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With METALLURGICAL SUPPLEMENT.

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VOL. CXLIX.—No. 3864] LONDON: FRIDAY EVENING, JANUARY 31, 1930 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

CALORIFIERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 18th February, 1930, for INSTALLATION of CALORIFIERS, &c., at the State Institution, Rampton.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4327

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 14th February, 1930, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Telephone Exchange, Leyton, E.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to the persons who send in Tenders in conformity with the conditions. 4328

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for—

17 LOCOMOTIVE BOILERS, 0-6-2 type.

Tenders due 21st February, 1930.

Forms of Tender available from the above at a fee of 5s., which will not be returned. 4350

Applications are Invited for a POST as TECHNICAL OFFICER in the Admiralty Technical Pool, for service in an Admiralty Establishment at Portsmouth, in which the work consists mainly of the Production of Designs relating to the Construction and Installation of Torpedo Tubes in above-water and submarine vessels.

Applicants should possess an Honours Degree or its equivalent in Engineering, together with Works and Drawing-office experience. The scale of salary of a Technical Officer is £250 by £20 to £450 per annum, with Civil Service bonus in addition. Present total remuneration on entry is £358 per year. Preference will be given to ex-Service men.

The Admiralty Technical Pool includes the following grades :—

Chief Technical Adviser (£800 by £50 to £1000 per annum).
Principal Technical Officer (£650 by £25 to £750 per annum).
Senior Technical Officer (£500 by £25 to £600 per annum).
Technical Officer (£250 by £20 to £450 per annum).
Junior Technical Officer (£175 by £15 to £235 per annum).

Applications should be made to the SECRETARY OF THE ADMIRALTY (C.E. Branch), Whitehall, London, S.W. 1. 4344

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1950.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for Dar es Salaam Harbour Scheme for a tour of 20 to 30 months' service. Salary £480, rising to £600 by annual increments of £20, and thence rising to £720 a year by annual increments of £30. (The question of paying a higher commencing salary than the minimum of the foregoing scale will be considered in the case of a highly qualified candidate). Outfit allowance of £30 on first appointment (provided the commencing salary is not over £600 a year). Free quarters and passages, liberal leave on full salary. Candidates, not over 40 years of age, must be fully qualified civil engineers who have had experience of block making and block setting in connection with harbour and dock works.

M/1898.—ASSISTANT ENGINEERS (SURVEYORS) (4) REQUIRED by the GOVERNMENT of TANGANYIKA for the Railways Department for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising to £600 by annual increments of £20, and then rising to £720 by annual increments of £30. (The question will be considered of paying a higher commencing salary than the minimum of the foregoing scale to a highly qualified candidate.) Outfit allowance of £30 on first appointment, free quarters, passages and liberal leave on full salary. Candidates, not over 40 years of age, must be experienced Railway Engineers with a knowledge of Railway Survey and Location Work, preferably on Colonial or South American Railways.

M/1973.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TRINIDAD for the Public Works Department, for three years' service, with possible extension, at a salary of £500, rising to £600 a year by annual increments of £25. Free passages. Candidates, 25 to 30 years of age, preferably unmarried, must have passed Sections A and B of the examinations for the A.M.I.C.E. Diploma or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations, and have had at least five years' practical experience upon Engineering Works of some magnitude, especially in the construction and maintenance of Roads and Bridges.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 4351

County Borough of Stockport.

ELECTRICITY DEPARTMENT.

TENDERS are INVITED for ONE 60-Ton ELECTRIC CRANE and GANTRY.

Form of specification and Tender, returnable by 18th February, 1930, may be obtained from Mr. R. Lee, A.M.I.E.E., Borough Electrical Engineer, Electricity Offices, 23, Tiviot Dale, Stockport.

ROBERT HYDE,
Town Clerk.

Town Hall, Stockport,
28th January, 1930. 4343

The Engineer

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PUBLIC NOTICES

University College of South WALES AND MONMOUTHSHIRE.
COLEG PREIFATHROFAOL DEHEUDIR CYMRU A MYNWY.

The following SCHOLARSHIPS, tenable for three years by students who intend to enter some branch of the engineering profession, will be OFFERED for COMPETITION at an Examination to be held at the College, which begins on APRIL 26th, 1930.

(i.) An Engineering Scholarship, provided by the South Wales Institute of Engineers, of the value of £70 per annum.

(ii.) The Excelsior Wire Rope Company's Scholarship, of the value of £50 per annum.

Further particulars can be obtained from the undersigned, to whom forms of application must be returned on or before March 22nd, 1930.

D. J. A. BROWN,
Registrar.

University College, Cardiff,
January, 1930. 4297

Belfast Harbour.

TO DREDGING CONTRACTORS AND DREDGING PLANT OWNERS.

The Belfast Harbour Commissioners are prepared to receive TENDERS for the SUPPLY and DELIVERY at Belfast Harbour of the following NEW or SECOND-HAND DREDGING PLANT, which must be in first-class working order and condition, viz.:—

ONE BUCKET LADDER DREDGER, bucket capacity not less than 15 cubic feet, capable of dredging to a depth of at least 48ft. below water level.

ONE PUMPING ASHORE PLANT, capable of handling the spoil lifted by the above dredger, and 3000 to 3600 Feet of Pipe Line, complete with necessary bends, flexible joints, branches, valves, &c.

Fully detailed particulars of the plant offered should be given and should include age, place of construction, classification, &c., where it may be inspected, and the earliest date for delivery.

Tenders should be enclosed in a sealed envelope, endorsed "Dredging Plant," addressed to the undersigned and sent in on or before Wednesday, the 12th February, 1930.

The Commissioners do not bind themselves to accept the lowest or any Tender.

M. J. WATKINS,
General Manager and Secretary.

4313

PUBLIC NOTICES

Barking Town Urban District COUNCIL.

OPEN-AIR SWIMMING BATH AT LONGBRIDGE PARK.

TENDERS FOR FILTRATION AND PURIFICATION PLANT.

The above Council invites TENDERS for the INSTALLATION of a FILTRATION and PURIFICATION PLANT at the above.

Full particulars and form of Tender can be obtained upon application to Mr. R. A. Lay, Assoc. M. Inst. C.E., Engineer and Surveyor to the Council, Public Offices, East-street, Barking.

Tenders are to be forwarded in the special envelope provided for the purpose, so as to reach the undersigned not later than 7 p.m. on Friday, February 14th, 1930.

The Council does not bind itself to accept the lowest or any Tender.

By order,
S. A. JEWERS,
Clerk to the Council.

Public Offices, Barking,
28th January, 1930. 4342

Bognor Regis Urban District.

WATER DEPARTMENT.

The Council of the Bognor Regis Urban District invite TENDERS for the PROVISION of certain PUMPING MACHINERY at their Eastergate Pumping Station. The plant will comprise a Vertical Oil Engine arranged to drive a Centrifugal Pump through gearing, and a Vertical-spindle Well Pump through electric transmission.

The specification with general conditions and form of Tender may be obtained (on payment of Two Guineas, returnable if a bona fide Tender be made), together with a copy of the drawings, on application at the Water Department Office, London-road, Bognor Regis, Sussex, and at the offices of T. and C. Hawksley, Civil Engineers, 34, Old Queen-street, Westminster, S.W. 1, on and after 29th January, 1930.

Tenders must be delivered at or before Ten o'clock in the Forenoon of 26th February, 1930.

The Council do not pledge themselves to accept the lowest or any Tender.

J. JUBB,
Clerk to the Council

Bognor Regis,
January, 1930. 4311

PUBLIC NOTICES

City of Leicester—Water DEPARTMENT.

SECOND DERWENT PIPE LINE.

The Water Committee are prepared to receive TENDERS for the LAYING of 12 MILES of 36in. diameter WATER MAIN.

The specification, bill of quantities and form of Tender may be obtained by application to the undersigned, and the drawings and all documents in connection with the contract may be inspected at the Waterworks Offices, Bowling Green-street, Leicester.

Tenders, duly signed and enclosed in a sealed envelope endorsed "Second Derwent Pipe Line, Contract No. 2," and addressed to the Chairman of the Water Committee, Bowling Green-street, Leicester, must be received by 10 a.m. on the 14th day of February, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

G. T. EDWARDS, M. Inst. C.E.,
4240 Engineer and Manager.

Corporation of Oxford.

TENDERS FOR PUMPING MACHINERY.

The Corporation of Oxford are prepared to receive TENDERS from responsible manufacturers only for the MANUFACTURE and ERECTION of ENGINES and PUMPING MACHINERY with AUXILIARY ENGINES and ACCESSORIES for their new Pumping Station at Swinford, in Berkshire.

The main engines are to be oil driven, and the pumps are to be capable of delivering 2 2/3 million gallons of water each per day; there will be four sets of main engines, each driving two pumps, two oil-driven auxiliary engines, each driving an electric generator, an electric lighting installation, air compressors, and other accessory machines.

Drawings may be seen and the conditions of contract, specification, schedule of prices, instructions to persons tendering and form of Tender obtained on and after Thursday, the 6th February, until Noon on Saturday, the 1st March, 1930, at the offices of the Engineers, Sir Alex. Binnie, Son and Deacon, Artillery House, Artillery-row, Westminster, S.W. 1, on payment of a cheque for £10 made out to the Corporation of Oxford, which amount will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Swinford Pumping Machinery," should be delivered at my office at or before Noon on Monday, the 24th of March, 1930.

The lowest or any Tender will not necessarily be accepted, nor will any expenses in connection with tendering be defrayed. Tender forms will not be issued after noon on Saturday, the 1st March. The Tenders sent in must be accompanied by the schedules fully filled in.

ARTHUR HOLT,
Town Clerk.

Town Hall, Oxford. 4308

Egyptian Government.

TENDERS are CALLED FOR by the Mechanical Department, Ministry of Public Works, for the SUPPLY and ERECTION of HIGH-TENSION OVERHEAD TRANSMISSION LINES in isolated Basins of Upper Egypt.

Tenders should be submitted direct to the DIRECTOR-GENERAL, Mechanical and Electrical Department, Ministry of Public Works, Cairo, not later than Noon on the 30th April, 1930.

Copies of the necessary conditions of Tender, specifications and drawings, &c., can be obtained on application to the Chief Inspecting Engineer, Egyptian Government, 41, Tothill-street, S.W. 1, against remittance of £10 5s. per set, which sum is not returnable. Copies of these documents are also available for scrutiny at the above address.

Firms on the Continent should apply to the Egyptian Consulate in their respective countries for the above-mentioned documents. 4326

Farnham Urban District COUNCIL.

WATERWORKS.

TO BRITISH MANUFACTURERS OF CENTRIFUGAL DEEP WELL PUMPS OR ELECTRICAL PLANT.

The Farnham Urban District Council are prepared to receive TENDERS for the COMPLETE EQUIPMENT of ELECTRICALLY DRIVEN PUMPING PLANT, in duplicate, of British manufacture, to be installed in and over two bored wells at their Darvills-lane Pumping Station.

The works included in the contract consist of Turbine Deep-well Pumps, each driven by an Electric Motor, together with all necessary Electrical Equipment and Connections inside the building and in accordance with drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification and copy of the drawing may be obtained by the manufacturer at the office of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Pumping Plant" must be delivered at my office at Farnham before Noon on Wednesday, the 26th day of February, 1930.

The Council does not bind itself to accept the lowest or any Tender.

(Signed) A. A. MINNS,
Acting Clerk.

Council Offices,
Farnham, Surrey. 4337

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PUBLIC NOTICES

County Borough of Blackpool.

HIGHWAY DEPARTMENT.
PARTICULARS OF ENGINES AND BOILERS FOR SALE.

TWO CYLINDRICAL MULTITUBULAR BOILERS, horizontal type; makers, Tangye, Birmingham; one 5ft. dia., 12ft. long; one 5ft. 6in. dia., 14ft. long; stipulated pressure, 120 lb per square inch; in good condition, recently inspected with "No defects observed" by insurance company.

ONE TANGYE COMPOUND VERTICAL STEAM ENGINE, indicated horse-power, 37; recently overhauled throughout, thoroughly reliable and direct coupled to

ONE 12in. TANGYE CENTRIFUGAL PUMP, shrouded phosphor-bronze impeller, steel shaft, rated capacity 2500 g.p.m., cond. moderate.

ONE TANGYE COMPOUND VERTICAL STEAM ENGINE, indicated horse-power, 25; in moderately good condition, direct coupled to

ONE 10in. TANGYE CENTRIFUGAL PUMP, shrouded phosphor-bronze impeller, steel shaft, rated capacity 1700 g.p.m.; condition moderate.

Any of the above steam engines or pumps will be sold singly or together.

TWO 8 H.P. TANGYE GAS ENGINES, tube ignition, town's gas, in good working order, with Gas Bags and Piping.

TWO 7in. BELT-DRIVEN CENTRIFUGAL PUMPS, complete with Countershaft and Pulleys, all in good working condition.

All the above may be seen at the Rigby-road Depot.

FRANCES WOOD, M. Inst. C.E.,
Borough Engineer and Surveyor.

Municipal Buildings,
Town Hall-street, Blackpool,
January 24th, 1930. 4312

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF PHOTO PRINTS, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of PHOTO PRINTS, &c., for the periods of 6 and 12 months, commencing 1st April, 1930.

Tenders must be submitted on the official form (Contract No. 27), which may be obtained from the Chief Engineer on and after Monday, 20th January, 1930, by personal application at the Offices of the Board (Room 156), or upon forwarding a stamped addressed sack envelope. Samples of the paper required can be seen at the Offices of the Board (Room 201).

Tenders, enclosed in sealed envelopes addressed to The Clerk of the Board and endorsed "Tender for Photo Prints, &c.," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 17th February, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
14th January, 1930. 4251

Metropolitan Water Board.

TENDERS FOR PIPELAYING, &c.

The Metropolitan Water Board invite TENDERS for PIPE-LAYING, ALTERATIONS and BRICKLAYERS' WORK within the areas of their Kent, Northern, Southern and Western Districts, commencing 1st April, 1930.

Tenders must be submitted on the official forms (Contract No. 17), which may be obtained from the Chief Engineer on and after Monday, 20th January, 1930, by personal application at the Offices of the Board (Room 156), or upon forwarding a stamped, addressed sack envelope.

Tenders, enclosed in sealed envelopes, addressed to The Clerk of the Board and endorsed "Tender for Pipe-laying, &c.," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 17th February, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
14th January, 1930. 4252

Parish of Ipswich.

HEATING AND HOT WATER SUPPLY INSTALLATION FOR THE PROPOSED NEW NURSES' HOME AT THE IPSWICH POOR LAW INSTITUTION.

The Guardians of the Poor of the Parish of Ipswich invite TENDERS for a CENTRAL HEATING and HOT WATER SUPPLY INSTALLATION, to be provided in the New Nurses' Home proposed to be erected at Heathfields, in accordance with the plans and specification prepared by the Guardians' Architect, Mr. J. A. Sherman, 9, Northgate, Ipswich.

Plans and specification can be seen at the Architects' Office, and copies may be obtained on payment of a fee of One Guinea, which will be returnable on receipt of a bona fide Tender which is not subsequently withdrawn. Applications will not be accepted later than Wednesday, 5th February.

The contractor will be required to pay such rates of wages as are recognised by the trades unions concerned, or are generally accepted as fair in the respective trades.

The Guardians do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed "Heating Installation, Nurses' Home, Heathfields," must reach the undersigned not later than Twelve Noon, Thursday, February 20th next.

By Order of the Board,
L. W. GREENHALGH,
Clerk to the Guardians.

Guardians' Offices,
19, Tower-street, Ipswich,
25th January, 1930. 4310

Southport and District Water Board.

BLUNDELL HOUSE PUMPING STATION.
CONTRACT No. 1: BORE-HOLES.

The Water Board are prepared to receive TENDERS from competent contractors for SINKING and TEST PUMPING THREE BORE-HOLES, each 39in. to 18in. diameter and about 750ft. deep. The site of the work is in the parish of Halsall, near Ormskirk.

Conditions of contract, specification, schedule of prices and form of Tender may be obtained from the undersigned, upon deposit of a cheque (only) for Two Guineas, which deposit will be returned upon receipt of a bona fide Tender and the return of all documents.

Sealed Tenders, endorsed "Tender for Bore-holes," must reach the undersigned not later than 10 a.m. on February 10th, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

C. BURTON EDE, M. Inst. C.E.,
Engineer and Manager.

14, Portland-street, Southport,
29th January, 1930. 4338

City of Sheffield Water Department.

BURBAGE RESERVOIR AND WORKS.
RESIDENT CONSTRUCTING ENGINEER.

APPLICATIONS are INVITED for the APPOINTMENT of a qualified RESIDENT ENGINEER in connection with the Construction by direct labour of a Large Storage Reservoir on the Burbage and Houndkirk Moors, situate seven miles from Sheffield, at a salary of £1000 per annum.

The Engineer will be responsible for the preparation of all plans and designs, and for the construction of the reservoir and works connected therewith. He must be a qualified engineer and have had considerable practical experience in the design and construction of storage reservoirs, preferably formed by earthwork embankments.

The person appointed will be required to enter upon the duties at once, reside in the immediate vicinity of the works, and devote the whole of his time to the performance of his duties under the Corporation.

Applications, stating age, qualifications and experience, accompanied by copies of three recent testimonials, and endorsed "Burbage Engineer," to be sent to me not later than Tuesday, the 4th February.

Canvassing will disqualify.

WILLIAM TERREY,
General Manager.

Waterworks Office, Town Hall,
Sheffield, 9th January, 1930. 4336

PUBLIC NOTICES

West Midlands Joint Electricity Authority.

IRONBRIDGE GENERATING STATION.

TENDERS are INVITED by the above-named Authority for the SUPPLY, DELIVERY, and ERECTION at their Ironbridge Generating Station of COAL-HANDLING PLANT, comprising Equipment for Unloading from Railway Trucks, Storing and Reclaiming.

Copies of Specification No. 8 and form of Tender may be obtained from Mr. E. F. Hetherington, M.I.E.E., M.I. Mech. E., Chief Engineer and Manager, at the offices of the Authority, on payment of a deposit of Two Guineas, which will, after the Authority have come to a decision on the Tenders received, be returned to the tenderer providing he shall have sent in a bona fide Tender and shall not have withdrawn it.

Additional copies of the specification may be obtained on payment of One Guinea per copy, which will not be returned.

Tenders must be forwarded under sealed cover, endorsed "Tenders for Contract No. 8, Ironbridge Generating Station," so as to reach the undersigned not later than Noon on Wednesday, 19th March, 1930.

The Authority do not bind themselves to accept the lowest or any Tender.

H. F. CARPENTER,
Clerk and Treasurer.

Offices of the Authority,
Phœnix Buildings,
Dudley-road, Wolverhampton,
24th January, 1930. 4302

WAYLEAVES.

Ex-Officer Required for Negotiating Wayleaves

for OVERHEAD LINES; one with Survey Experience preferred.

Replies, stating age, experience, and salary expected, to—

THE SECRETARY,
Aldershot Gas, Water and District Lighting Co.,
4340 Victoria-road, Aldershot.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

THE ADVERTISERS Under Box "H." Kidd's Advertising Agency, Middlesbrough, WISH to THANK THOSE who APPLIED for the POSITION of WORKS ENGINEER, and would inform them that this POST has now been FILLED. 4314 A

WANTED AT ONCE for Service in Iraq, First-class OIL ENGINE FITTER with Practical Knowledge of Internal Combustion Marine Engines. Single man, not over 30. First agreement three years, salary Rs. 400 per month, plus allowance for messing. Passage paid; medical expenses and furnished quarters free.—Address, giving full details experience and reference, 4330, The Engineer Office. 4330 A

WANTED, an ENGINEER of Good Education in a large works manufacturing Oil and Steam Engines, Pumps and Lifting Appalinces; must have really up-to-date knowledge of Works Lay-out and Organisation, including Tooling and Gauging methods, Drawing-office experience and technical training essential.—Address, stating full experience, age and salary required, 4341, The Engineer Office. 4341 A

WANTED, as Works Manager, Young, Energetic, loyal and enthusiastic ENGINEER. Experience of Factory Management essential. Works 30 miles from London. Send copies of testimonials and particulars of education and past experience to Z. A. 900, c/o Deacon's Advertising Offices, Fenchurch-avenue, E.C. 3. 4329 A

WANTED, by London Firm of Engineers' Merchants, Smart REPRESENTATIVE for Sale of good Specialities. Good salary, commission and expenses and car provided for right man, who would be willing to invest not less than £500 in business, which would be guaranteed.—Address, 4334, The Engineer Office. 4334 A

WANTED, CAPABLE ENGINEER, with Good Executive Experience, to Take Charge of Production in works of Electrical Engineers in London area. Thorough knowledge of Small Repetition Work and latest Production Methods. Ability to handle labour essential. State experience, salary required, and age, otherwise application will not be considered.—Address, P6641, The Engineer Office. P6641 A

WANTED, COLLIERY ELECTRICAL ENGINEER, to deal with Electric Power Supplies to Collieries.

Candidates should have had a regular training and be conversant with Modern Colliery Practice. Good salary and prospects to the right man.

Address, stating age, training, references and salary required, 4307, The Engineer Office. 4307 A

WANTED, ENGINEER to Act as Clerk of Works, to Layout, Organise and Supervise Erection of Coke Oven, Blast-furnace and Steel Works Plant during Reconstruction. Only energetic men with the right experience need apply.—Address, giving fullest particulars of experience, stating age and salary expected, 4323, The Engineer Office. 4323 A

A MANUFACTURING FIRM in the Midlands REQUIRES a Competent MECHANICAL ENGINEER, young and with active brain, capable of designing and Improving the Manufacture of existing All-metal Joiners' Tools; generous remuneration to the right man.

Address, with references, giving full particulars of qualifications and experience, P6633, The Engineer Office. P6633 A

ENGINEER REPRESENTATIVE for London and South of England District. Complete Workshop experience essential and must have thorough technical training.—Address, P6626, The Engineer Office. P6626 A

GAS PRODUCER SALESMAN REQUIRED for London.—Address, with full particulars, P6637, The Engineer Office. P6637 A

GENERAL WORKS, or FOUNDRY MANAGER, REQUIRED for a Steel Foundry in the Midlands, operating on Small and Intricate Castings, Electric and Converter Processes. Excellent prospects, permanent situation. Applicant must be thoroughly experienced in all Types of Steel Castings. A really good position is assured to anyone having the necessary qualifications.

Address, stating age, experience, &c., P6632, The Engineer Office. P6632 A

INDUSTRIAL ENGINEER, Age 28-35, Sound Technical education, a University Engineering Degree preferred. Four to five years' practical shop experience essential. Position offers attractive financial future. Post in Great Britain.

Candidates, in replying, should state age, present salary, and general qualifications.

Address, P6596, The Engineer Office. P6596 A

JUNIOR ASSISTANT REQUIRED to Managing Director of Company manufacturing Electrical Switchgear; must be good correspondent, energetic, have initiative, and judgment, and preferably had experience in this class of business. State age, experience and salary required.—Address, 4341 The Engineer Office. 4341 A

WORKS MANAGER as Assistant to a Director of Yorkshire Engineering Works employing about 200 men, conversant with latest Shop Practice for Non-repetition Work, able to get best results out of machines and men under his control; wide workshop experience, agreeable personality essential. Age 28/42 Commencing salary £500 to £600 per annum.—Address, giving references, 4306, The Engineer Office. 4306 A

WANTED, DRAUGHTSMAN for New and Reconstruction Work by an Iron and Steel Company, owning Coke Ovens, Blast and Steel Furnaces and Rolling Mills. Must be a capable and reliable Estimator. None but those used to the above class of work need apply. Good prospects for right man.—Address, giving fullest particulars, stating age and salary required, 4322, The Engineer Office. 4322 A

SITUATIONS OPEN (continued)

WANTED, Experienced DRAUGHTSMAN, Used to Designing and Detailing Package Conveyors of all kinds. Permanent position for right man.—Address, stating qualifications, experience and salary required, P6620, The Engineer Office. P6620 A

WANTED, Smart DRAUGHTSMEN, Preferably with experience in the Lay-out of Centrifugal Pumps, for work in the South of England.—Address, giving full particulars of experience, and salary required, 4346, The Engineer Office. 4346 A

WANTED, TWO or THREE Good Experienced DRAUGHTSMEN, having thorough knowledge of Commercial Vehicle Engine and Chassis Work.—Write only, stating age, experience and salary required, in confidence, to COMMER CARS, Ltd., Luton. 4301 A

WANTED, 2 or 3 DRAUGHTSMEN with some experience on Machine Tool Work (experience in Jig and Tool Work is not sufficient).—Address, stating age, experience and salary required, 4300, The Engineer Office. 4300 A

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ENGINEER, 23 Years of Age, DESIRES POST, home or abroad; 8 years' locomotive, carriage and wagon experience, home railway (5 years workshops, all departments, and 3 years drawing-office). Could be free in four weeks.—Fullest particulars from BM/DB 44, London, W.C. 1. P6628 B

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JUNIOR DRAUGHTSMAN, Experience Estimating and costing, drawing-office, machine shops, four years' technical training, will ACCEPT POSITION other than draughtsman if necessary. Disengaged.—Address, P6649, The Engineer Office. P6649 B

JUNIOR DRAUGHTSMAN (19½) SEEKS SITUATION; 3½ yrs.' engineering shops experience, 2 yrs.' D.O.; Polytechnic student.—W. N. BUTTON, 85, Marcia-road, London, S.E. 1. P6648 B

JUNIOR DRAUGHTSMAN (20) SEEKS SITUATION; 2½ years general apprentice in workshops, 3 years university, 3 months D.O., mechanical and structural.—Address, P6625, The Engineer Office P6625 B

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WANTED, POSITION as FOREMAN of Packing and Despatch Dept. in Engineering Works. Thoroughly experienced.—Address, P6627, The Engineer Office. P6627 B

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A Seven-Day Journal

Electrical Distribution in Manchester.

A FEW days ago the Chief Electrical Engineer at Manchester, Mr. H. C. Lamb, read a paper before the Manchester Association of Engineers on the electrical distribution system of that city, in the course of which he referred to the many variations of adopted practice in distributing electrical energy. Those variations, he said, were partly the result of the different conditions to be met in one area and another, but much more of a conflict of opinion in earlier days. Some thirty or forty years ago an acute controversy took place between the advocates of alternating and direct current distribution. Unfortunately, in this country, the views of the direct current champions mostly prevailed, particularly in the industrial towns where the future importance of the power load was recognised. Some years later, however, the development of the polyphase motor made alternating current just as suitable for power purposes as direct current. The economies of alternating current as compared with direct current had been recognised for a considerable time, and although the direct current system was originally adopted in Manchester, the numerous new housing areas had all been laid out for alternating current and many small districts had been detached from the direct current system. The street mains and the consumers' installations had been converted to the alternating current supply at the standard pressure of 230 volts. Approximately 9000 consumers had been changed over. A change of that character was expensive, but a considerable part of the cost might have been saved had the work simply involved changing from direct current without raising the pressure. It was clear, however, that standardisation would offer advantages in the future, both to the consumer and supply authority, and for that reason it was decided to raise the voltage to the standard value.

Rationalisation in the Scottish Steel Industry.

WITH a view to increasing the efficiency of production in the steel works of the Clyde area, an arrangement has been made between William Beardmore and Co., Ltd., of Parkhead Forge and Mossend Steel Works, and David Colville and Sons, Ltd., of Motherwell, whereby the goodwill of the Beardmore undertaking, in so far as it applies to the production of plates, sections and rails, will be acquired by David Colville and Sons, Ltd. The arrangement, which does not involve any amalgamation, exchange of shares, or merging of financial or other interests, will come into operation as from to-morrow—Saturday, February 1st. The immediate closing down of the Parkhead plate and sheet departments will involve the passing out of employment of about 600 men, but it is understood that about £100,000 will be spent during the coming year in re-equipping the Parkhead Forge to deal exclusively with the manufacture of heavy forgings, wheels, axles, tires, guns and armour plate, in which Messrs. Beardmore have so long specialised. By arranging that, each works shall concentrate on the intensive production of the particular class of work for which it has been laid out, and by ensuring as far as possible a larger volume of work it is hoped to reduce the cost of production of all the various articles mentioned and thereby render the competitive power of the Clyde iron and steel industry more effective. It is understood that the arrangement provides for the continuation of the present policy by each firm, even in the event of later fusion or amalgamation developments.

State Assistance for Electricity Scheme.

WITH the consent of the Minister of Labour and of the Treasury, the Unemployment Grants Committee has approved a grant to the Central Electricity Board to meet, for a time, the burden of expenditure involved in carrying out the North-East England electricity scheme. An announcement issued a few days ago from the Lord Privy Seal's office states that owing to the extent to which this particular area is already developed, the gross expenditure involved in standardisation is estimated at £9,000,000 at least, whilst the construction of the "grid" in the North-East area will involve the expenditure of a further £1,000,000. Although it is considered that the inclusion of this scheme will be a great national benefit, the cost of standardisation if imposed as an immediate burden on the supply industry would counteract the benefits of interconnection and endanger the prospects of the national scheme. Nevertheless, it was felt that it would be unwise to delay the work, and as we have previously reported, it has been decided to accelerate the programme so that the work may be carried out in a period of five years. The Unemployment Grants Committee has, therefore, approved of a grant. The whole of the interest charges will be met for a period of seven years, and half the interest charges thereafter up to a total of fifteen years from the date of expenditure. But in the event of the development of electricity being sufficiently rapid for those charges to be borne partly, or wholly, by the industry without undue hardship at an earlier date, the State contribution will then be reduced, or will be withdrawn. The grant will enable the work to be put in hand at once and pushed forward as rapidly as possible, and a substantial amount of employment will, consequently, be found in the North-East England area, as well as in other manufacturing areas.

New Merseyside Dock Schemes.

IN answer to a question which was asked in the House of Commons on Tuesday last, January 28th, Mr. J. H. Thomas, Lord Privy Seal, stated that three dock schemes had been submitted by the Mersey Dock and Harbour Board, involving an expenditure of 2¼ million pounds. Two of the schemes, Mr. Thomas said, had already been approved, and the other scheme after being approved in principle was now being examined in detail. Notification will be sent to the Board, and it is hoped that work will be begun at no distant date. One of the first schemes will be the construction of a new dock at the Old Float at Birkenhead and Wallasey. Another scheme provides for alterations to the Clarence half-tide dock and graving dock basin, in order to provide by the building of new quay walls, bridges, and passages adequate communication with the North Dock system. It is also intended to remove the Trafalgar lock and to enlarge and deepen the entrances to the West Waterloo and Salisbury docks, giving a through connection between the Prince's Dock and the Surdon Dock system, and on, if needed, to the Gladstone Dock. The extensions will necessitate a large amount of reinforced construction work, and also the building of several new bridges. Referring to financial assistance to be granted to British port schemes under the Development (Loan Guarantees and Grants) Acts of 1929. Mr. Thomas said that financial assistance had already been approved in the case of dock and harbour schemes affecting the ports of Dundee, Wick, Milford, Bristol, Shoreham, Leith, Liverpool, and Cullen, and consideration was now being given to schemes affecting other ports.

The Late Comm. Ing. E. Ferretti.

THOSE who attended the Summer Meeting of the Institution of Naval Architects in Italy will learn with regret of the recent death of Comm. Ing. Ernesto Ferretti, the Chief Inspector of the Registro Italiano Navale ed Aeronautico, who assisted Admiral Sechi in making the arrangements for the meetings which were so very successful. At the time of his death Engineer Ferretti was in his sixty-seventh year. He studied civil engineering at the University of Bologna from 1885 to 1887, and for the three following years he took a course in mechanical engineering at the Polytechnic School at Naples. From 1890 to 1892 he studied naval architecture at the Royal School of Naval Architecture and Engineering in Genoa. Following his period of studies, he spent some time in the Royal Italian Dockyards, and was engaged on the construction and trials of battleships and submarines. He became an officer of the Royal Italian Navy, and a member of the Royal Corps of Naval Architects. During the war he was engaged on liaison work between the British and Italian fleets, and his services were honoured by the British Government. Shortly before his death Engineer Ferretti wrote an interesting article on the progress of Italian shipping under the Fascist Government, which appeared in the January annual review of our contemporary the *Journal of Commerce*. In his work for the Italian classification society, he came into close contact with the officials of different classification societies, and his death will be keenly felt in a wide circle of friends.

Next Year's Schneider Trophy Race.

THE decision of the Government not to take official part again in the Schneider Trophy contest was widely regarded with regret on the score that without Government backing it would probably be found impossible for any firm to build and enter a machine and to incur the very heavy financial outlay involved in competing for the Trophy. It seemed, in fact, very probable that the Government's decision would result in this country's having to forego its chance of winning the Trophy outright by securing it for the third time within five consecutive years. The position is not, however, quite clear at present. It is possible that without departing from the spirit of its decision the Government might do very much to assist the entry of machines by private enterprise, as, for example, by lending pilots from the High Speed Flight section of the R.A.F.—which section is being retained—to operate manufacturers' machines and thereby relieving the entrants of the heavy expenditure involved in training the pilots. Whether any firm will be found willing to undertake the production of a new machine for the Race is not, however, certain at present. It is therefore interesting to note that, according to a report, a British civilian pilot has expressed his willingness to have a machine constructed for the contest next year. He does not propose to fly it himself, but has nominated another pilot to do so. The last date for the receipt of entries is July 31st this year. The race will take place between June 1st and September 30th, 1931, on a date to be fixed three months beforehand. An important change in the conditions of the Race has just been announced by the Federation Aeronautique International. The water-tightness and navigability tests which have previously been made on the day before the actual flight are to be abolished, and in their place a getting-off and alighting test is to be carried out immediately before the contest and on the same day as that on which it is held. This change may have an important influence on the design of the machines entered for the Race.

The Iron and Steel Industry and the Coal Bill.

FOLLOWING the protests against the Coal Mines Bill made by the Federation of British Industries and the British Engineers' Association, to which we called attention last week, the fact can now be recorded that the National Federation of Iron and Steel Manufacturers has also made representations to the Government regarding the provisions of the Bill and their reaction on the iron and steel industry. The industry objects to the principle of compulsory amalgamation on the ground that no amalgamation enforced by statute on unwilling parties can be successful in its working. It also objects to the Bill generally because it holds that it must inevitably increase the cost of coal, the principal raw material of the iron and steel industries. The importance of this point, it says, cannot be exaggerated, for coal, as such or in the form of coke, represents over one-third of the total cost of iron and steel products. Any further burden imposed on the iron and steel industry will, it is contended, only accelerate the decline in productive and employment capacity which is at present in progress. The Federation believes that the Bill will do nothing to assist the ultimate recovery of the coal mining industry, and may do much to hinder the recovery of general industry. If, in spite of the opposition which has been expressed, the Government decide to proceed with the Bill, the Federation urges that all fuel used in the iron and steel industries should be excluded from the operation of Part I. of the measure. It has pointed out to the Government that the necessity for such exclusion has already been recognised and successfully met by the Five Counties Scheme, which practically exempts from its provisions all fuel required for metallurgical purposes.

Two Cruisers Cancelled.

LAST spring Parliament voted a sum of £842,002 for the work to be done during the year ending next March on the two 10,000-ton cruisers "Surrey" and "Northumberland," which were to have been built at Portsmouth and Devonport dockyards respectively. In July the Prime Minister announced that work on the construction of the vessels had been suspended. On Monday of this week an Admiralty Fleet Order intimated that their construction had been definitely cancelled. It is not known how much work had been done on the construction of the ships up to July, when the suspension order came into force, but as each cruiser, exclusive of armament and ordnance, would have cost about £2,200,000, it is evident that their cancellation will effect a considerable financial saving in the expenditure on the Navy. Financial economy seems to have had more to do with the decision not to proceed with the building of the ships than any desire or intention to anticipate the outcome of the present Five-Power Naval Conference. The "Surrey" and "Northumberland" were cruisers of the "London" class, and were designed by Sir William J. Berry, late Director of Naval Construction. Since its advent to power Mr. Ramsay Macdonald's Government has, in addition, cancelled the construction of a submarine depôt ship and two submarines, and has slowed down dockyard and other naval establishment works.

Engineers' Wages.

IN March, 1928, the engineering trades unions submitted to the employers a demand for an advance of 8s. per week in the wages of plain-time workers and for corresponding increases in piecework prices. The demand was rejected. It was renewed in June, 1929, but in November the employers again rejected it, their principal grounds for doing so being the state of the export trade, the burdens placed on industry by the Government's financial policy, and the reaction on the demand for naval work consequent upon disarmament. Last week seventy-five delegates, representing twenty-eight unions, met in London to consider the situation caused by the employers' decision of last November. Reports were presented from the executives of the various unions, and it was decided to appoint a deputation to meet the employers for the purpose of discussing the position in the light of these reports. It is freely stated that it is the unions' intention to ask the employers to agree to the wages claim being referred to arbitration. If this proposal is not accepted, the unions, it is reported, will approach the Government and urge it to arrange an investigation into the engineering industry on the same lines as those adopted in connection with the investigations into the cotton and the iron and steel industries.

Sheffield Water Supply—New Works in the Ewden Valley.

ON October 11th last the two new reservoirs—the Broomhead and More Hall—and other works, which the Sheffield Corporation Water Department had had under construction for a number of years past in the Ewden Valley, were formally put into service by the Rt. Hon. Arthur Greenwood, the Minister of Health.

The undertaking of the Sheffield Waterworks Company was acquired by the Corporation in 1888. Rather more than twenty years before that date, the Company had obtained Parliamentary sanction for the construction (*a*) of the Broomhead and More Hall reservoirs, in the Ewden Valley, lying north of the Loxley Valley between Oughtibridge and Bolsterstone, and (*b*) of a service reservoir at Wadsley. The Company even went so far as to purchase the necessary land for these purposes, since it anticipated that the additional supplies would shortly be required. However, in 1870 certain regulations, having for their object the prevention of waste, or the misuse of water, were sanctioned and put into force, with the result that extensive waste of water was detected and suppressed. Such good effect did this abatement of waste have upon the Company's resources that the construction of the reservoirs was postponed. The land for them had, however, been acquired, as explained above, and it passed into the hands of the Corporation when the latter took over the remainder of the Company's assets.

For a number of years thereafter the water resources as they existed at the date of the purchase, remained sufficient to satisfy the City's needs, and the building of the dams was again delayed.

In 1895 the Barnsley Corporation promoted a Bill in Parliament for obtaining extensive powers within the Little Don watershed, and as Sheffield looked upon that district as being her own particular territory and natural source of additional supplies when they became necessary, steps were taken to oppose the Bill. The latter, notwithstanding, passed the House of Lords and was about to be taken to the House of Commons when Parliament was dissolved. In the next session, Sheffield deposited a competing Bill, in which powers were sought for the carrying out of a comprehensive scheme of works. The outcome was that an arrangement was arrived at by which Barnsley acquired the right to impound the waters of the Hagg Brook, while Sheffield obtained control of the Little Don Valley watershed, with powers to construct the Langsett and Underbank reservoirs within it. As an offset, the Corporation came under obligation to afford to the Corporations of Rotherham and Doncaster an aggregate supply of 2,600,000 gallons of water per day from the Langsett reservoir, and as a time limit was set, it became necessary immediately to carry out the construction of the works in the Little Don Valley. Thus the formation of the Broomhead and More Hall reservoirs was still further postponed.

A few years later the proposal to construct waterworks in the Derwent and Ashop Valleys was brought forward, and in 1899, after a long Parliamentary contest, in which Mr. William Terrey, who was then, and still is, the able General Manager of the Sheffield Waterworks Department, played an important part, the Derwent Valley Water Board was constituted. It consists of representatives of the County Borough of Derby, of the Cities of Leicester, Nottingham, and Sheffield, and of the Derbyshire County Council. By Sec. 89 of the Derwent Valley Water Act, 1899, the Board was under obligation to construct, as a first instalment, works in the Derwent Valley capable of affording a total supply of not less than 12 million gallons a day. Of that total, Sheffield's share was 25 per cent., and the City had to contribute a quarter of the total cost of the works—whether it used the water or not—besides having to meet the cost of a tunnel—the Rivelin tunnel, which is some 4¼ miles long—to make the supply available in its area. With a view to avoid duplicate charges and the waste of public money, the construction of the Ewden Valley works was again postponed.

However, in order to meet the growing requirements of the district, it at last became necessary, in 1913, to begin the construction of the Broomhead and More Hall reservoirs. Then came the war, which

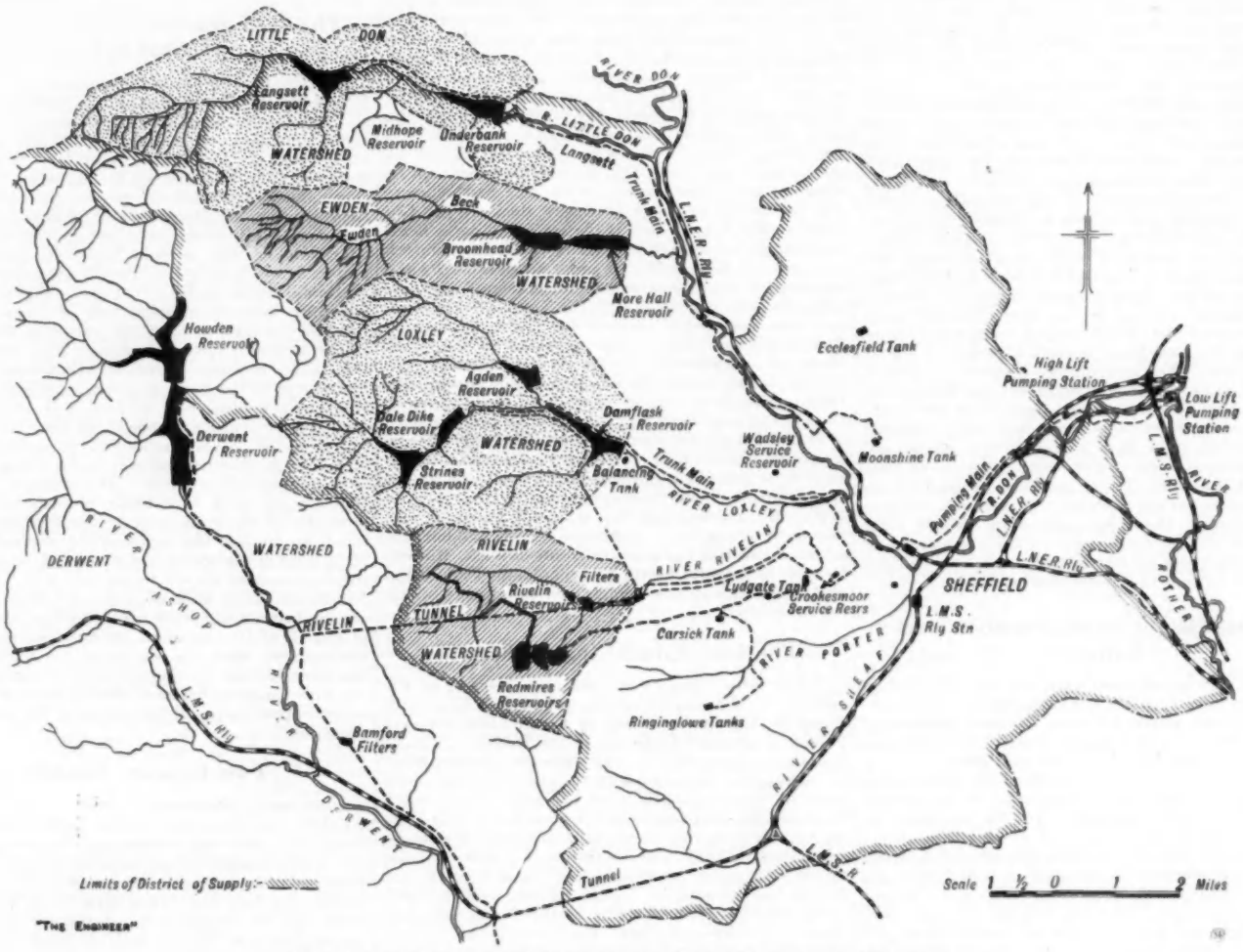


FIG. 1—MAP SHOWING SOURCES OF THE WATER SUPPLY OF SHEFFIELD

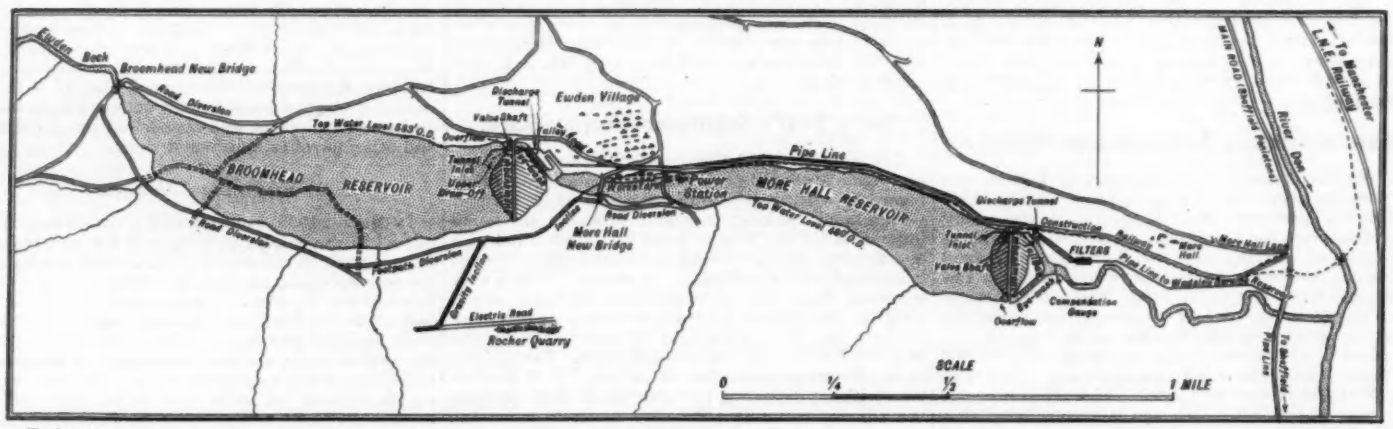


FIG. 2—PLAN OF BROOMHEAD AND MORE HALL RESERVOIRS

not only delayed the works, but substantially increased their costs. The Water Committee decided that the works whould be carried out by direct labour under the supervision of a resident Engineer, who should be solely responsible for their design and construction, with a consulting engineer whose duty it should be to examine all designs and plans, and regularly to inspect the works in progress and advise and report thereon. The reservoirs were designed by and constructed

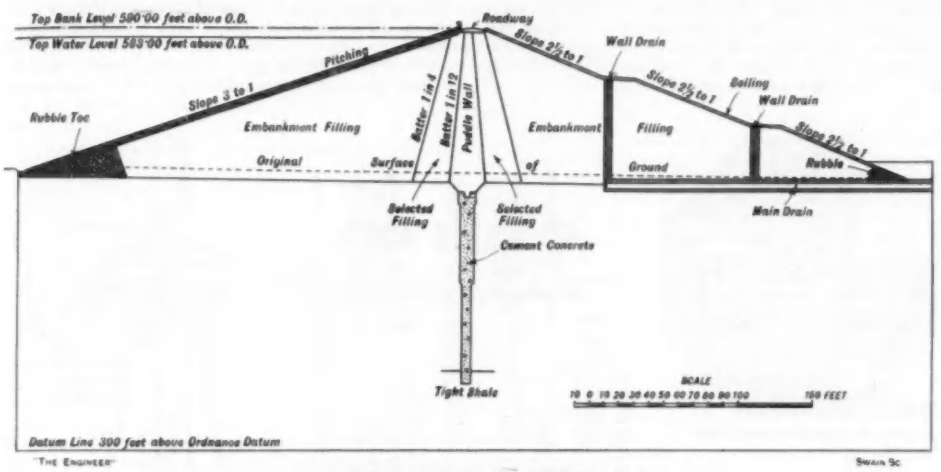


FIG. 3—TYPICAL CROSS SECTION OF BROOMHEAD DAM

under the supervision of the late Mr. Colin Clegg, M. Inst. C.E., who, unfortunately, did not live to see the completion of the labours to which he had whole-heartedly devoted his energies, for he died on September 11th last, just before the new works were put into service. The Consulting Engineers appointed were Messrs. T. and C. Hawksley, of Westminster.

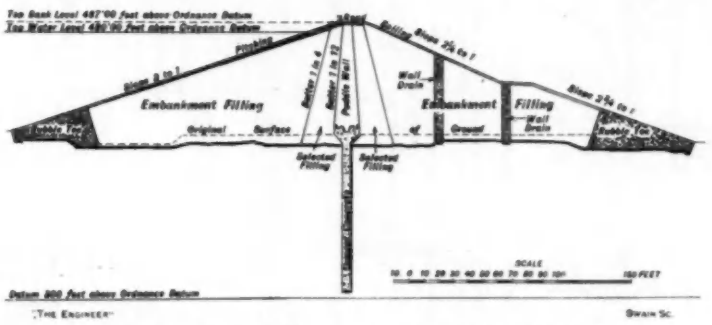


FIG. 4—TYPICAL CROSS SECTION OF MORE HALL DAM

The works provided employment for some 400 to 500 men during a period of ten years.

The positions of the new reservoirs, as well as those of the other gathering grounds from which the City of Sheffield derives its water supplies, may be seen on the accompanying map, Fig. 1, while their relative positions are shown in Fig. 2. The two reservoirs receive the flow from a drainage area of 6496 acres. The average daily quantity of water available is 7,249,536 gallons, but of that total, 2,629,373 gallons a day have to be discharged as compensation water into the Ewden Beck, leaving just over 4,620,000 gallons a day available for the supply of the City and district.

The site on which the reservoirs are founded consists mostly of shales, which extend up and down the valley for some considerable distance. These shales, which are in the millstone grit series, occupy a position above the Rivelin, or Chatsworth grit, and below the middle grits. The rocks slope as a whole from the south-west to north-east across the valley at a dip of about 10 deg. Landslips in the valley were indicated in the Geological Survey Map, and they were found, during excavation operations, to exist—though some of them were not deep—and, where necessary, they were removed. However, both the Broomhead and More Hall trenches had to be taken down to greater depths than had been originally anticipated owing to the extent to which the measures below ground level had been disturbed.

The concrete trench for the Broomhead Reservoir dam, which has a length of 1148ft., has a maximum depth of 158ft., and an average depth of 120ft. At its lower part it is 6ft. wide, the upper part being given double that width, and it is filled with 33,000 cubic yards of concrete. During the excavations, large volumes of water, which reached nearly 2½ million gallons per day, were encountered and had to be evacuated by pumping. The puddle wall was made 24ft. wide at the base, tapering to 6ft. wide at the top. It contains 41,000 cubic yards of material and rests upon the concrete a few feet below the surface of the ground, being carried up to top bank level so as to constitute an impervious core about the centre of the width of the embankment. A typical cross section of the dam is given in Fig. 3. It will be observed that the faces of the core wall have a batter of 1 in 12, and that upstream and downstream it is protected by a tapering wall of selected filling, the outer faces of which have batters of 1 in 4. The upstream embankment, which is furnished with a rubble toe for a width of some 70ft., has a slope of 3 to 1 and is pitched with stone throughout. The downstream embankment, which has a rubble toe some 25ft. wide, has formed in it two vertical drainage walls, connected at their bottoms with a main drain. These walls have the effect of dividing the slope of the embankment into three sections, each having a slope of 2½ to 1, berms of much less slope being formed where the tops of the walls come. The top of the embankment is traversed by a roadway some 15ft. wide, which has a parapet wall on the reservoir side.

The embankment, which has a length of 1000ft., and a width at the base of 594ft., was taken up to a height of 104ft. above the river bed. It contains 686,000 cubic yards of earthwork, and 230,000 cubic feet of quarry-dressed stone. A tunnel, which was driven through the solid ground on the north hillside, was used to take the flow of the river during construction, and is now used for drawing off the water from the reservoir. It has a length of 1100ft. and is horseshoe shaped in cross section, measuring 12ft. wide and 10ft. high. It was driven by hand and is lined with concrete faced with brickwork. In it, immediately upstream of the valve shaft, is a concrete "stop piece," 17ft. 6in. long, which is faced on the downstream side with a cast iron bulkhead, 1¼in. thick and through which passes a 54in. to 36in. taper discharge pipe.

The valve shaft, which was sunk from the hillside about midway on the line of the discharge tunnel, involved heavy excavation, concreting and timbering. The shaft, which is 100ft. in depth, has a diameter of 20ft. and is lined with brickwork. We refer again to this valve shaft and its equipment later in this article.

A waste, or overflow, weir, which is 200ft. long has been constructed at the top water line on the north side of the reservoir to carry off surplus or flood water. This weir discharges into a bye-wash, which is formed of 48 curved stone steps 50ft. wide, and is spanned near the overflow weir by a footbridge in the line of the embankment to give access to the various parts of the works. The length from the centre line of the trench to the gauge weir is 720ft.

The drainage area of the Broomhead reservoir is 5427 acres. When filled, the reservoir has a water area of 123 acres and a capacity of 1142 million gallons. The top water level stands at 583ft. above O.D., the top of the embankment coming at 590ft above O.D. The maximum depth of water impounded is 93ft.

The More Hall Reservoir, which is formed on lines somewhat similar to those of the Broomhead Reservoir, saving that the downstream rubble toe is considerably wider, is to be used wholly for compensation purposes. The shales across the valley on the line on which the embankment was constructed were found to be very much distorted and crushed, so that, to secure a sound bottom, it was necessary to excavate the trench to a maximum depth of 103ft., the average depth being 80ft. The trench is 1029ft. long and 6ft. wide throughout its depth, and it was filled with 19,000 cubic yards of concrete. The puddle wall—see Fig. 4—is 17ft. wide at the base, tapers to 6ft. wide at the top, and contains 20,500 cubic yards of material. The embankment is 820ft. long and 80ft. high above river level. The width at the base is 462ft. and the outside and inside slopes have batters of 2¼ to 1 and 3 to 1 respectively. The total quantity of banking material required was 354,000 cubic yards, with 176,000 cubic feet of stone pitching on the inside slopes. The discharge tunnel is similar to the Broomhead tunnel, but the fall is greater. It is carried through solid ground on the north side of the valley, its length being 761ft. and its cross section 12ft. by 10ft. The valve shaft, which is 80ft. deep and 14ft. in internal diameter, is constructed of concrete and is furnished with five platforms connected by ladders.

The More Hall drainage area is 1069 acres, and the capacity of the reservoir is 476 million gallons. When full the reservoir will have a water surface area of 65 acres. The top water level is 480ft. above O.D., and the greatest depth is 73ft. The overflow weir is 264ft. long and the bye-wash has a length of 700ft. and a width of 58ft. A water bay has been formed at the foot of the embankment to receive the compensation and flood waters before they are discharged into the river. For the purpose of determining the statutory compensation water to be sent downstream, a mill gauge has been arranged at the foot of the outer slope of the embankment. It is a rectangular notch gauge, the flow over which is continuously registered by an automatic recorder. The millowners have right of access to the gauge for the purpose of ascertaining its state of repair and efficiency, and the quantity of water discharged.

For dealing with the water discharged for supply purposes from the Broomhead Reservoir, a battery

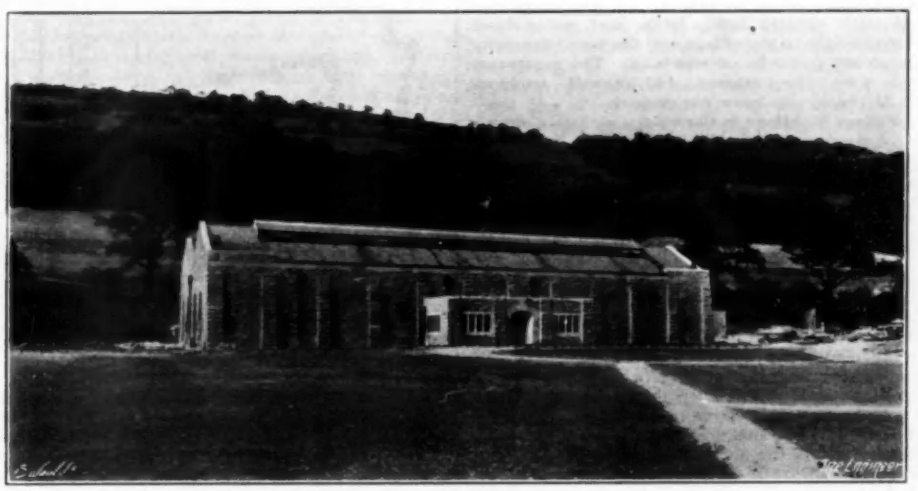


FIG. 5—THE FILTER HOUSE

of thirty-two pressure filters has been provided by the Paterson Engineering Company, Ltd. It is housed in an imposing stone building, a view of which is given in Fig. 5. This building measures 140ft. long by 71ft. wide, and is lighted by a roof light which runs its entire length. The filters are 8ft. in diameter and each has a filtering area of 1600ft. The plant is designed to filter 4 million gallons per day, but the filter building is

large enough to accommodate twenty-four additional filters, so that an ultimate maximum quantity of 7 million gallons per day may be treated. The water coming from the reservoir actuates turbines—see Fig. 6—which drive the chemical proportioning pumps and the agitators in the reagent tanks. The pumps inject the required quantity of coagulant into the raw water in its passage along the raw water main to the filter house. The water is filtered downwards through the sand bed in the filter and is collected at the bottom into a strainer system, consisting of a cast iron header pipe with copper pipe laterals, each pipe having small holes closely pitched along the whole of its length. Passing through the strainer system, the purified water is collected into a pure water outlet main, into which is automatically introduced about half a grain of lime per gallon to neutralise the acid tendency of the moorland water. The introduction is effected by small turbine-driven plunger pumps. A Venturi meter of the integrating type provides a continuous chart record of the volume of water passing through the filtration plant.

The filtered water is conveyed through a 36in. trunk main, 7½ miles in length, partly into the Moonshine service reservoir—see Fig. 1—and partly into a reservoir at Wadsley, which formed part of the works recently constructed. From these reservoirs it is distributed to the low-level districts.

For the purposes of the works, a standard gauge railway had to be constructed between the London and North-Eastern Railway at Wharncliffe Woods and the site, a distance of 2¼ miles. To provide the large quantities of stone required for masonry and concrete, the "Rocher" quarry, which is situated on the south side of the valley, was opened out and the stone was delivered from it to the works by gravity inclines. A model village was also built. The houses were of two kinds. The first provided

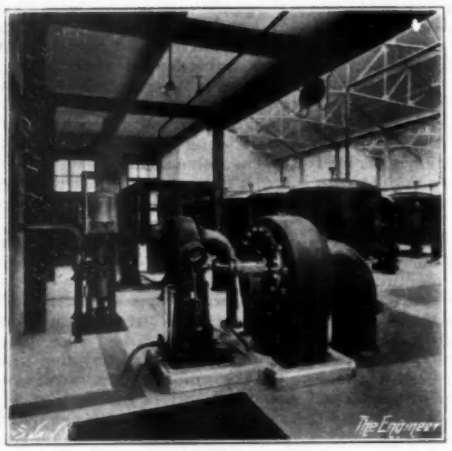


FIG. 6—TURBINES AND VENTURI RECORDER

accommodation for married men and contained a living-room, a kitchen, and three bedrooms. The second class, or lodgers' hut, provided accommodation for thirteen single men, with separate sleeping rooms, together with a central dining or living room for the men, and a private sitting-room and two bedrooms for the hut-keeper and his family. Garden allotments were set apart for the workmen. All the houses were fitted with electric light, bath, and water-closet. To furnish light to the village and the works generally, a temporary power-house was built. The generators, which were direct-current, 440/500-volt machines, were driven by producer gas engines.

The other buildings in the village include a church, a large recreation room measuring 85ft. by 28ft., a sick and accident hospital, a canteen and a "sale shop." Fire hydrants, which are under the control of a well-organised fire brigade, are fixed in the main thoroughfares throughout the village. The village and accommodation buildings were erected by Mr. F. T. Walker, of Sheffield.

As some of the old roads in the valley were submerged, about 2½ miles of new public roads and footpaths had to be constructed, and two bridges built over the Ewden beck. In addition, in order to provide convenient access to both reservoirs, the Corporation built a new road, 22ft. wide and 2¼ miles long, from the Wadsley, Sheffield, and Langsett main road alongside the reservoirs to Cooper Carr-road, and thence to the Mortimer-road leading to the Langsett reservoir on the north and to High Bradfield on the south.

A series of views of various portions of the works is given on page 136.

We now return to the valve shafts, the valves and accessories in which were supplied by Guest and Chrimes, Ltd., of Rotherham, under the general instructions of Mr. Terrey. The valve shaft, &c., of Broomhead reservoir are illustrated in Fig. 7. The shaft is, as has been said above, 100ft. deep, and it is furnished with six intermediate platforms, supported on cast iron girders, the plates being perforated cast iron. The various platforms are connected by wrought iron ladders, having double rungs. A gap is left in each platform plating to allow of the hoisting and lowering of material up and down the shaft, these gaps being fenced round with wrought iron railings. At the bottom of the shaft two 36in. sluice valves A and B, arranged in tandem, are attached to the 54in. to 36in. taper pipe, which, as already explained, passes through the "stop piece" in the discharge tunnel from the reservoir. To the outer flange of the second 36in. valve is bolted an expansion joint Tee pipe C, an enlarged view of which is given in Fig. 8, and which is introduced to facilitate the removal of the valves for repair when necessary. This expansion joint is fitted with a gun-metal bushing at the bottom of the stuffing-box, and gun-metal glands. The sliding spigots also have a gun-metal sleeve. The end pressure on the joints, when the outer of

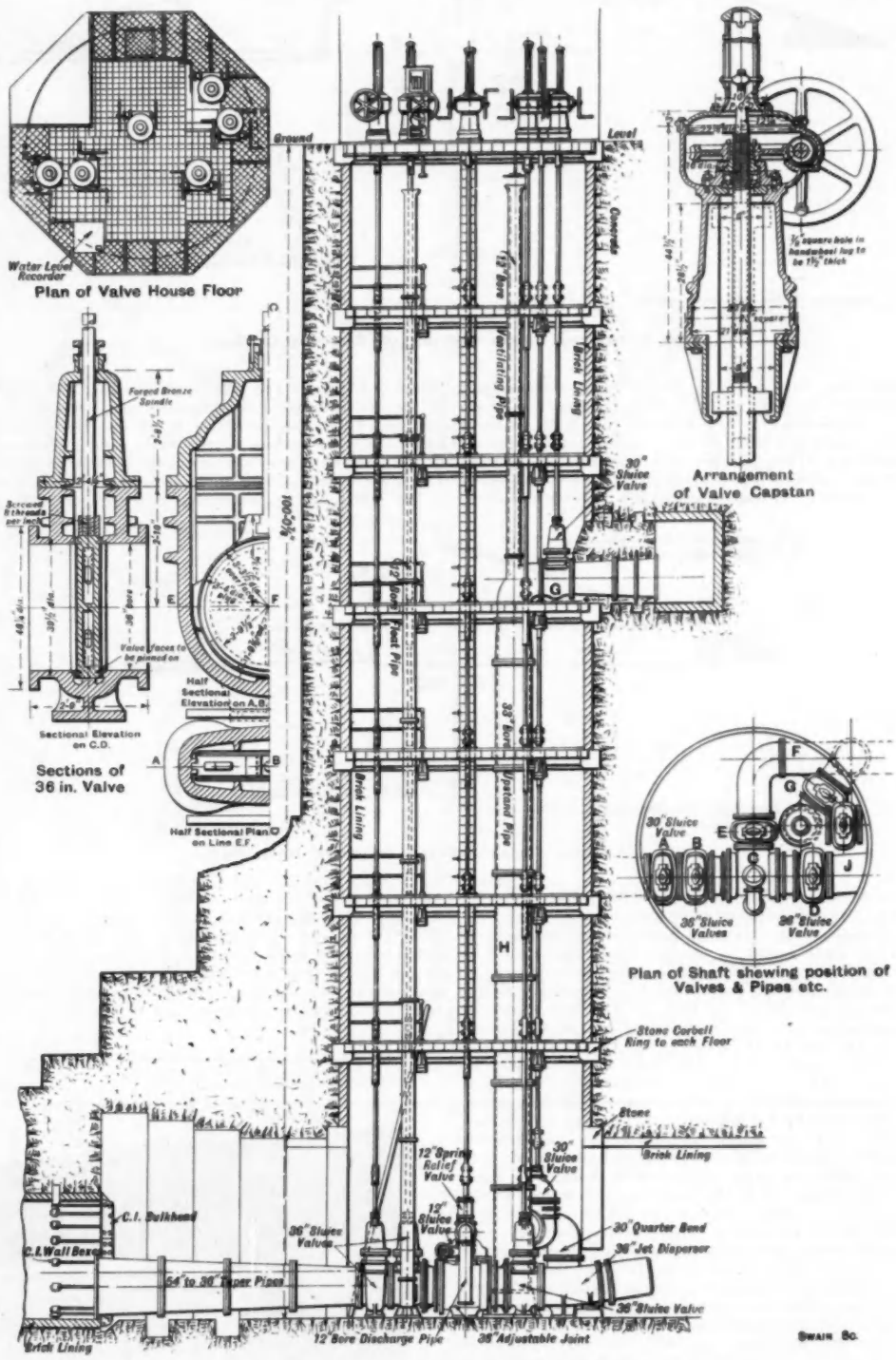


FIG. 7—BROOMHEAD RESERVOIR—VALVE SHAFT

the two 36in. valves is closed, is taken by safety bolts. To the opposite end of the Tee pipe is bolted another 36in. sluice valve D, and, when required, the water can be passed directly through all three valves A, B and D in series into the discharge tunnel running to the More Hall reservoir. When that is done the water is made to traverse a 36in. disperser, which is bolted to the outer flange of the third 36in. valve D, and which has the effect of dissipating the force of the water and of causing it to be discharged into the tunnel in the form of spray so as not to damage the lining. To a 30in. flanged aperture on the horizontal centre line of the Tee pipe at right angles to the valves already mentioned, is bolted a 30in. sluice valve the outer flange of which is connected by means of a right-angled bend to a 30in. pipe F, which leads to the filter house, and in which there is an automatic stop valve.

Arranged at the top of the Tee pipe is a 12in. spring-loaded relief valve, the duty of which is to relieve water pressure in case the draw-off valves are suddenly shut off and the water pressure increases abnormally owing to concussion. In that event the water is allowed to escape into the tunnel. Immediately below the relief valve is a 12in. sluice valve, through which the water has to pass on its way to the relief valve, so that when it is closed the latter can be removed for overhaul or repair.

The arrangements so far described relate to the drawing off of water at the lowest permissible point in the reservoir, *i.e.*, some 91ft. from top water level. As will be seen from Fig. 7, however, there is another possible draw-off point, which is 60ft. higher up. There, a 30in. sluice valve G is bolted to a taper pipe, which is set in a block of concrete and the other end of which communicates with a brick-lined rectangular conduit communicating with the reservoir. To the other flange of the valve G is bolted a bend, from which a 12in. open-topped ventilation pipe is taken vertically up to above top water level in the reservoir, and the other end of which is bolted to a 33in. upstand pipe H, which is taken down to the bottom of the shaft, where, by means of a further 30in. valve J, it is connected to the 30in. pipe F leading to the filters. It will have been gathered from the foregoing that it is possible, by suitably opening and closing the various valves, to discharge water (*a*) from the lower draw-off point either directly into the tunnel running to the More Hall reservoir, or (*b*) from the lower draw-off point to the filters, or (*c*) from the same point to the tunnel and filters

simultaneously, or (*d*) from the upper draw-off point to either the tunnel, or to the filters, or to both, as may be desired.

The valves, sections of one of which are shown in Fig. 7, are of the parallel faced type with their bronze sliding pistons cottered to steel lifting rods. The latter are operated by capstans arranged on a platform at the top of the valve shaft. The capstans, one of which is also shown in Fig. 7, have gun-metal worm wheels keyed to gun-metal screwed nuts revolving in ball thrust bearings. The double steel worms which are cut out of the solid shaft have double thrust bearings and work in an oil bath. All the hand wheels have chromium-plated rims with wooden handles. A hood indicator, which shows the position of the valve to full scale, is provided at the top of each capstan.

The top floor and capstans are supported by two 20in. by 7½in. rolled steel joists with cast iron cross girders, the flooring being glazed with floor lights 1in. thick. In addition to the capstans, there is on the operating platform a water level recorder and indicator which is designed to show on a dial, to within ½in., the height of water in the reservoir, and also to trace a record to a scale of ½in. to 1ft., on a seven-day paper diagram. The recorder mechanism is actuated by a clock with a dead-beat escapement and a pendulum with a wooden rod and a heavy bob. Running down to the bottom of the valve shaft is a 12in. float pipe, which is open at the top and which, at the bottom, is connected by a 1in. copper tube to one of the 36in. valves attached to the outlet pipe coming from the reservoir. The level of water in the float pipe is, therefore, the same as that in the reservoir. Free to move up and down in the pipe is a float and from it a bronze cord is taken up over a spiral drum which forms part of the indicating and recording mechanism. The other end of the cord passes downwards through the floor of the operating platform and has attached to it a balance weight. The spiral drum is geared by a worm and

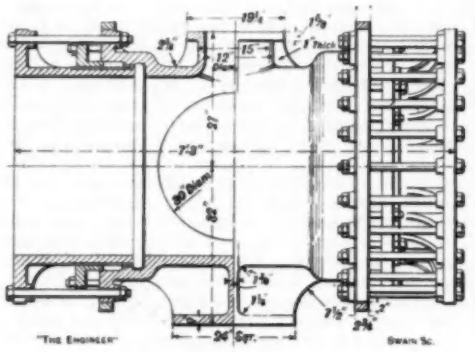


FIG. 8—EXPANSION JOINT TEE PIPE

worm wheel to the operating mechanism and by means of spur gearing to the dial. The latter has two scales and two pointers. One scale, which has divisions each representing 1ft., shows the full depth of water in the reservoir for one revolution of the pointer. The other scale, which has divisions each representing ½in., shows a variation of 1ft. in level for one revolution of the pointer.

We understand that the makers adopted a high factor of safety for the valves and piping, and that both before and after erection everything was tested to a pressure equivalent to that produced by an 800ft. head of water.

The equipment of the valve shaft at the More Hall reservoir, which was also supplied by Guest and Chrimes, Ltd., is on the same general lines as that just described, but is not so elaborate, as no discharge to filters had to be provided for since the reservoir is only used for compensation water The shaft, which is 80ft. deep, contains three 36in. sluice valves with jet dispersers, and one 24in. valve for future use.

The total capital expended on the scheme up to March 31st, 1929, was £1,750,365.

In conclusion, we desire to offer our best thanks to Mr. William Terrey for permission to publish this article and for courteously supplying the necessary materials, as well as for valuable assistance readily afforded to us during its preparation.

Institution of Mechanical Engineers

THE WOOD STEAM GENERATOR.

THE paper presented last Friday evening before the Institution of Mechanical Engineers was of unusual interest. Mr. E. Watson Smyth, of Manchester, gave an account of the "Wood Steam Generator," and described his experiences with the operation of the first boiler of that type produced in this country. The paper—we begin to reprint it in full elsewhere in this issue—was unusual in that it dealt very frankly and fully with the initial troubles and difficulties which were encountered and with the modifications in the design which were adopted to overcome them.

The meeting was very well attended and there was a lengthy list of speakers in the subsequent discussion. It may be said generally that those who spoke were united in praising the courage required to lay bare the early defects and difficulties and in bearing testimony to the value to be derived from a study of "failures." They were, however, broadly divisible into two classes—those who had had practical experience with the operation of the Wood type of boiler, and those who were associated with the manufacture of other designs of steam generator. The users, notably Mr. John Christie, of Brighton, had very favourable reports to make concerning the performance and behaviour of the Wood generator as developed after the initial difficulties had been surmounted. Those whom we may call the rival manufacturers were mildly critical of the design, raising questions as to the validity of certain of the test figures quoted in the paper, suggesting here and there that the design was not as novel as it might seem and that it was still capable of being improved, and hinting that some at least of the early difficulties might have been avoided had established principles of boiler practice been studied.

In case any wrong impression should be conveyed by our report of the discussion, or by the paper itself, it seems desirable to say that the Wood boiler is now well past its "teething troubles," and is in active service in this country and abroad. The principle of the design remains unaltered, but in details the boilers of to-day are somewhat different from the preliminary and modified designs illustrated in the paper. The reader who is curious in this respect may turn to our issue of May 24th, 1929, in which he will find a fully illustrated description of the Wood boilers installed at the Southwick Power Station, Brighton. Corresponding developments in the United States may be studied by reference to our issues of August 5th, 1927, and February 24th, 1928, in which we illustrated the boilers in the Kip's Bay steam heat station, New York, in which Mr. Wood's principle is employed in combination with boilers of the Ladd type. It may be added that at the meeting there was exhibited a model of one of the two combustion steam generators fired with pulverised fuel, which Combustion Steam Generators, Ltd., of London, has installed at the Derby Corporation Electricity Works, and which are now steaming.

The President, Dr. Daniel Adamson, opening the discussion, recalled the late Mr. Michael Longridge's investigations of thirty years ago undertaken to discover whether it was possible to transmit heat at the rate of 40,000 B.Th.U.'s per square foot per hour. It was regarded in those days as hardly being attainable. It would be observed that in the Wood boiler that rate of transmission had not only been reached but exceeded.

Mr. Arthur Spyer said that he saw no reason to doubt the author's statement that in the Wood boiler it was possible to evaporate 90,000 lb. of water per hour with a pressure heating surface of only 1900 square feet. Many years ago Niclausse had shown that, at all rates of working, the bottom rows of a bank of tubes, twelve tubes in height, by reason of their direct exposure to the fire were doing about 3½ times as much work as the average over all the rows. In the Wood boiler all the tubes were in effect bottom row tubes. The general principle of the water-walled combustion space was sound, but, if the life of the boiler was to be long, the water walls should not be worked at a high rate of transmission. It appeared from the figures given in the paper that the boiler was usually worked at something less than 90,000 lb. of water evaporated per hour, and that the normal rate of transmission was reasonable. The Wood boiler was, in effect, a furnace only, and should be regarded as one item of what used to be called a series boiler. Trouble, he observed, had been experienced by the formation of slag on the vertical water walls and had been overcome by restricting the ash content of the coal to a maximum of 12 per cent. The real remedy, he thought, was to take steps to prevent the accumulation of slag from causing trouble. It was doubtful, he concluded, whether the commonly expressed belief that the use of pulverised fuel would increase the range of fuels available would be realised, for slagging was likely to cause trouble with many of the lower-grade fuels.

Mr. Selvey remarked that boiler design had for many years advanced slowly because of the high state of perfection to which it had been brought. There was, however, no finality in any field of engineering. If the thermodynamic efficiency of boilers could not be improved it remained to attack the amount of material used in their construction and, therefore, the cost of manufacture. He hoped that when the costs of developing the Wood boiler had been recovered the benefit of the economies secured on the material side would be passed on to the user of the boiler. The ease with which radiant heat could be taken up by a surface had been repeatedly emphasised, and at last an inventor had made use of the fact in boiler design. It was natural that there should be practical difficulties at the outset, but he anticipated that the Wood design would be followed by many others seeking to take advantage of the radiant heat principle.

Mr. John Christie stated that, after seeing the early experiments with the Wood boiler at Messrs. Taylor's works at Manchester, he had taken the risk of recommending the Brighton Corporation to install boilers based on the same principle, but improved as a result of the experience gained with the experimental unit. These boilers were now running and were a wonderful revelation to power-house engineers. It was quite easy to increase the evaporation in a few seconds from 30,000 lb. to 70–80,000 lb. per hour. Simply by the pushing of a button an increased output of 30–40,000 lb. could be obtained in a minute at the utmost. The evaporation factor was very high and might reach 47 lb. of water per square foot of heating surface per hour. No fusing, burning, or warping had so far been observed in the Wood boilers at Brighton. The flue gas analysis showed under all conditions a CO_2 percentage of 15 to 17½ per cent., and, therefore, indicated a combustion efficiency which was superior to that given by a brick-lined furnace. One of the Brighton boilers was now being equipped for oil firing, a fact which suggested the application of the Wood boiler for use at sea. The "Mauretania's" twenty-five large Scotch boilers might, he estimated, be replaced by eight Wood boilers, giving 30 per cent. more steam, occupying much less space, and having but half the weight of the existing equipment.

Major Thompson could not agree with an assertion made by the author that one of the advantages possessed by the Wood boiler was its ease of manufacture. He thought it would be difficult rather than easy to produce. The efficiency figure of 89·5 per cent. quoted by Mr. Smyth was not exceptional. That figure, and even up to 91 per cent., had been guaranteed by other makers. As regarded the claims made for the small space occupied by the Wood boiler, he argued that the space saved was not very considerable, for, in fairness, the room occupied by the coal pulverising plant, the air heaters, the economiser, &c., ought to be taken into consideration. In estimating the evaporation per square foot, he thought the surface reckoned upon ought to include that in the economiser and the air heater. It would certainly appear that the Wood boiler possessed great flexibility of output. He hoped that its reliability and its maintenance costs would be equally satisfactory.

Mr. A. D. Maclean confirmed Mr. Christie's figures as to the ease with which the rate of evaporation could be increased in a few seconds, and added that, from his own personal experience, no damage was done to the boiler by such sudden changes in its output. Provision was made for very free expansion in all directions, the heat transmission surfaces were everywhere thin and no thermal stresses were set up at any point. The paper had been described as a "chapter of failures," but a little stress might be laid upon the ultimate success which had been achieved. The Wood boiler as it stood to-day was a success. The employment of a high rate of transmission could be defended completely on the ground that the boiler was not used as a water softener, as boilers at one time had been.

Mr. Charles Erith said that the author had not made out his case for the downward discharge of the combustion gases. Nineteen years ago, in the Bettington boiler, the gas and ashes had been discharged through the bottom row of tubes, the coal used being non-pulverised. The application of fire tubes as water walls was not novel, for it had previously been made in the United States. The figure of 89·5 per cent. efficiency mentioned in the paper was, he thought, erroneous. It could not be accurate in view of the patent defects in the design. He suggested that a figure of 80 per cent. was more probable.

Mr. H. E. Geer, of the Superheater Company, gave some particulars of the superheater fitted to the first Wood boiler. It was the first superheater of its type supplied for use in conjunction with a water-tube boiler in this country. The original elements were still in service, although the superheater support had collapsed twice, and in spite of the fact that they were exposed to a temperature of about 1000 deg. Fah.

Mr. Pendennis Wallis compared the design of the Wood boiler with those evolved by contemporary workers on the Continent, and said that, in particular, it was very similar to a Benson boiler produced by Siemens-Schuckert. He suggested that convection as well as radiation took a part in the action of the Wood boiler.

Mr. Kirke said that the heating surface of the Wood boiler appeared to be about 13 per cent. of the floor area occupied by the unit. It seemed, therefore, impossible that the boiler could evaporate more water per square foot of floor area occupied than other boilers on the market. Nearly the whole of the heating surface was only half usable, for one side of the tubes alone did any work. Like others, he doubted the efficiency figure of 89·5 per cent. He suggested that the boiler was very much over-rated, that it should be considerably cut down, and that when it was so cut down it should be entirely redesigned.

Mr. J. O. Twinberrow corrected a slip made by Mr. Geer when referring to the Babcock and Wilcox boilers at the Calumet power station. Mr. E. R. Dolby drew attention to Perkins' employment of water walls in boilers about the year 1860.

Major W. Gregson thought that the design of the Wood generator called for criticism. The designer seemed to have concentrated entirely on the radiant heat factor and to have forgotten that quite a big proportion of the work done in a steam boiler must be effected by actual contact heating. The purely radiant heat section had been dealt with very scientifically, but Providence had apparently been relied upon to deal with the gases after they had passed through the water screen. That inference was borne out by the several changes that had been made in the arrangements for handling the gases in the lower ranges of temperature, although present-day knowledge of heat transference was quite sufficient to have enabled the designer to determine accurately what would occur at each stage. The maximum output had been aimed at in the purely boiler section, and then the air heaters and economiser had been added to effect the reduction of the gas temperature and so to improve the efficiency. He thought it was a retrograde step to take work off the boiler and to put it on to air heaters and economisers. It would appear that, on the average, the gases left the water screen at a temperature of about 1400 deg. Fah., and that about 62 per cent. of the total heat in the coal was absorbed in the boiler section proper. The remaining 38 per cent.—less the heat losses—had to be dealt with elsewhere. He contended that it would have been much more economical to have recovered a big part of the second percentage as direct steam than indirectly in the manner resorted to by the designer. In other words, it would have been sounder practice to add a section for contact heat absorption integral with the boiler proper, or, alternatively, to have adopted a definite two-stage design of boiler, one stage devoted to radiant heat absorption, and the other to contact heat absorption. Too much had, he thought, been attributed to the detailed design of the combustion chamber. The primary factor in giving the high rate of heat propagation was, he contended, the intimate association secured between the fuel particles and the air and the consequent very early attainment of a high temperature flame. He believed that it would be very desirable to eliminate the economiser from the Wood boiler and to adopt regenerative feed heating from the prime mover. At the Trafford Park Steel Works, the situation, he was aware, did not lend itself to regenerative feed heating. He suggested, therefore, that, as an alternative, the auxiliaries to the boiler should be steam instead of electrically driven, and that the exhaust steam should be used for preheating the incoming feed water. By such a plan the bulk of the charge for auxiliary power consumption, equivalent, he calculated, to about 1s. 6d. per ton of fuel consumed, would disappear.

Mr. Watson Smyth, replying briefly to the discussion, disclaimed responsibility for the design of the boiler, and stated that his duty had been connected with its operation. The efficiency figure of 89·5 per cent. recorded for the preliminary trials in 1925, was obtained by an independent authority and was the average for two tests, one lasting 7½ hours, and the other 5½ hours. As regarded the capacity of the boiler, he was prepared to show it at work any day on a fairly steady load evaporating 80,000 lb. of water per hour. In conjunction with a Ruths' steam accumulator, it was now operating all day and all night at a capacity of 70–90,000 lb. of steam per hour. He thought that there was a big field for the boiler at sea and particularly in the Navy.

Links in the History of the Locomotive.

BLENKINSOP LOCOMOTIVES AT THE KENTON AND COXLODGE COLLIERIES, 1813–1815.

By E. A. FORWARD.

No. II. (*conclusion*).*

THE next item of interest is a sheet of Memoranda dated May 16th, 1813. It reads as follows :—

" Distance from the Jubilee Pit to the Turnpike	1397 yds.
do from Turnpike to Ouse Burn Bridge	1446
	2843
	= 1¾ miles nearly
Distance from the Burn to Staith	5837 yds.
	= 3¼ mls. 117 yds.
Length of Bank from Burn	950 yds.
Ascent from Bridge to first hedge 1⅛ in 1y dis	210 yds.
do from first hedge to top of Bank ¾ in 1y dis	740 yds.
	950
Width of inside of our way .. .. 4′ . 7½″	
do outside .. .. .. 4′ . 11½″	

Mode to fill the boiler when at work.

What length of time is to elapse, or at what period is it proper to be filled.

House for the machine, the size, etc.

The propriety of having an engine to take the waggons up the Bank; having the rack in the middle of the way.

Fix about Brakesmen and a going over.

Mode of putting in crossing plates.

Wheel for the Rack railway should be sent over.

When can we expect the engine over.

Width between the waggon wheels at present used at Kenton Colliery 4′–4½″.

Total length of waggon way 8,718 yards.

Expense of keeping and working one of the Travelling engines is estimated at £5 10 0 per week including wear and tear of the same, and will take down the way from the pits to where the Kenton way joins Willington Waggon way a distance of 3¾ miles in the above time 216 chal[n] consequently will cost per chal 6½d nearly.

It will require 6 horses at least to do the above work and 6 waggon men which is estimated to cost as below

6 horses @ 28/- per week	8	8	0
6 men @ 20/- per week	6	0	0
Wear and tear of horses	1	2	0
	15	10	0

Consequently it will cost £15 . 10 . 0 to lead the same quantity as above, which will be per Cha. 1/5½, thereby saving 11d. per chal. which upon 36,000 chaldrons yearly will leave a saving of £1,650 independent of the saving of expense in (greasing) and ballasting the way."

From this memorandum, and a reference to the 6in. Ordnance map, the course of the line is fairly clear. The Jubilee Pit, Coxlodge, the most westerly point mentioned, lies about a mile north of the Town Moor, Newcastle, and three-quarters of a mile west of the main road to the north. Adjacent and slightly nearer to the road lies the Regent Pit. Fawdon is half a mile north-west of the Jubilee Pit, and all three appear to have been served by the same wagon way. The Jubilee Pit is 223ft. above Ordnance datum, and the line ran thence, with a slight fall, to the turnpike road. It then continued to Gosforth, dropping to the Ouse Burn, 75ft. below the Jubilee Pit, and having on this part a double right-angled turn, which Watson was evidently trying to straighten out for the benefit of the locomotive. The bank, 950 yards long, eastward of the Burn had a rise of about 80ft., or 1in. per yard, and from the head of this the line ran gradually downwards in an E.S.E. direction to a staith on the riverside at Wallsend, the total length being about 5 miles. It is not clear from the correspondence exactly where the locomotives worked, but if the turnpike could not be crossed by the engines, it would have been necessary for one engine to work the ¾ mile from the pits to the road and the other to work the 4¼ miles from the road to the staith. It would be interesting to know what happened on the somewhat formidable bank. It is evident from the viewers' report of 1815 that the rack rails had not at that date been laid as far as was originally intended.

On June 1st, 1813, Blenkinsop writes to Watson :—

" Dear Sir,

Enclosed I hand you Mr. Smith's letter / a gent in London whom I have employed to draw up the agreement / from which letter you will see what information he requires, but should no deed be in existence in which you are appointed manager, I should then suppose the agreement should be signed by the different owners. Your answer on this subject as early as your convenience will admit will enable me to bring the agreement ready for signature when I see you at the Races.

Mr. Murray was visible yesterday for the first time and I am sorry to inform you that he said it was impossible for them to execute the steam carriage in two months having such a large order in hand for Russia which they are bound to execute very shortly also an engine for Mr. Buddle which I believe is to be fixed underground at Percy Main, this latter engine I know has been ordered these three months, however, he says you shall have a capital machine carriage finished from 3 to 4 months, he promised to write to you on the subject and as he presumably devotes his Sundays for letter writing you may not expect to hear from him before Monday, but should advise you in the meantime to write to him which will have great effect. You can observe that he may use the things belonging our third engine, such as cylinders, pistons, toothed wheels, eccentric motion or any other thing which can be applyed to real use, provided he replaces those by October which is giving him 5 months.

You must have a wrought iron boiler with a double iron tube and if your road is good there is nothing to fear.

I remain
yours truly
J. BLENKINSOP
in haste."

The most interesting items here are Blenkinsop's suggestion that Watson should have a wrought iron boiler with a double flue tube for his next engine, and the mention of excentric motion amongst the parts Murray might use belonging to Blenkinsop's third engine, which he expected to have by October, 1813.

Watson evidently adopted Blenkinsop's suggestion and wrote to Murray on June 4th, receiving the following reply :—

Leeds, 14th June, 1813.

" We have your favour of the 4th. inst., respecting the dimensions of the Breadth of your Rail road the patern of which we have by us. Your observations about charging some of the materials belonging to Mr. Blenkinsop's engine will not answer any purpose in the saving of time and would considerably increase the expense of both.

We should have been very happy to have put this engine in hands immediately but we are under the necessity of employing all our fourse to get a large engine off to St. Petersburg which must sail in August otherwise shall be liable to a serious loss. Under these circumstances you will perceive that we cannot state the exact time but will do our utmost to get it done as soon as possible.

We are Sir
Your obedient servants,
FENTON, MURRAY & WOOD."

On July 8th, 1813, Blenkinsop wrote to Watson asking if the engine had been delivered from Leeds, while on July 23rd he inquires about the non-delivery of a cogged wheel which had been sent to Watson by Pickersgill's wagon five or six weeks earlier.

Watson wrote again to Murray on July 13th and received the following reply :—

Leeds, 2nd Aug. 1813.

" We have yours of the 13th. ult. requesting to know to a certainty when we can have your engine done. We can only refer you to our last and add that at present we are almost working night and day to finish those engines which must go from here to Russia the latter end of this month. After which time you may rest assured yours shall be one of the first jobs we begin upon. We hope we shall be able to complete it in two months but these engines are by no means yet a straight forward job and are attended with many difficulties in making of them and perhaps will be the case for some time yet.

I remain sir
for FENTON, SELF & WOOD
your most obedient servant,
M. MURRAY.

There is then a lapse of two months, during which period the first engine at Kenton had begun work, on September 2nd, so that three engines had been completed by that date.

Blenkinsop then writes to Watson :—

Middleton, 4th. Oct. 1813.

" Dear Sir,

Messrs. Fenton, Murray & Co., are getting forward with an engine for Percy Main and also with one for us in the room of Willington, after they are finished Murray informs me they will get rapidly forward with yours. He still says he has received no regular order for your second engine. I think therefore you had better write to him on the subject and request him to make you two engines with as much despatch as possible and then I should conceive he would consider it as a regular order. Shall I beg the favour of sending me a draft of £30 which is to be paid for each engine for the use of high pressure of steam, there has been application for it and I shall write and say that I propose making a remittance in a few days.

Murray has charged Willington to Mr. Brandling and I shall feel obliged to you if you can make it convenient to pay me before Xmas as at that time the books are closed for Mr. Brandling's inspection. I should not like Mr. B. to say he had paid for an engine which had gone elsewhere.

I am happy of informing you that I have got the noise of the steam taken completely off by fixing a wooden cistern between the cylinders as a receiver and a discharging pipe fixed on the top of it 8in. square inside and carried the height of the chimney. This box must come nearly to the bottom of the wooden receiver (inside) and the steam will discharge with more ease thus.

The box is made of ½in. or ¾in. stuff size 2′–1″ × 1′–6″ × 2′–9″ in ht. The wooden pipe is fixed a little at one side so as the steam not to blow into it from the cylinders but against the roof of the box.

There must be a small pipe at the bottom so as to carry off the condensed water or the cocks will be choked, the expense is very trifling in making a trial, both the engines here are done so.

I am dear sir
yours very truly
J. BLENKINSOP."

(A sketch on this letter shows the position of the silencer on the engine.)

From this letter we learn that Blenkinsop's third or spare engine which had been transferred to Watson was named " Willington," and that another was being made to replace it. An engine was soon to be started for Watson, who was ordering two engines for the Coxlodge line. It also confirms that Blenkinsop was paying a royalty to the proprietors of Trevithick's patent " for the use of high-pressure steam." Another very interesting point is the provision of exhaust steam silencers on the two engines working at Leeds.

On October 14th, 1813, Murray again writes to Watson :—

" We have your favour containing an order for two engines for leading coals upon Mr. Blenkinsop's principle which we will put in hands immediately and get done as soon as we possibly can.

In consequence of your getting Mr. B.'s spare engine, we are busy engaged making him another which he is impatient for as their chief leading for the supply of Leeds is in Winter; in the meantime your castings shall be put in hands and pushed before any other new work is begun of. I mentioned to you in a former letter that the making of these engines were by no means a straight

* No. I. appeared January 24th.

forward job and cannot be got on with the same facility as our other work. This being the case it is impossible for us to state precisely when they can be finished. We have had an engine of larger dimensions but of nearly the same description in hand these 6 months for Mr. Buddle is now nearly finished, we believe it is for drawing coals upon an inclined plane.

With respect to your order for a new piston and three small wheels, the three wheels we shall send you off in a day or to, but the piston we cannot make as we are not sure of the exact size of the cylinder or whether they are both one diameter. Metallic pistons are of no use but where they can exactly fit the cylinder they are made to. In your new engines we will endeavour to make the four cylinders one exact size, you can then have a pair of spare pistons to fit either engine which must be fit up with the piston rods at the same time the engines are made. We intend to make your fire place larger than Mr. Blenkinsop's which will give more power to the engine.

For FENTON, SELF AND WOOD,
Your most obedient servant
M. MURRAY."

Here we have Watson asking for a spare piston and wheels after the engine had been at work only six weeks, and the pistons were evidently fitted with metallic packing.

Blenkinsop writes again on October 20th, 1813 :—

" Dear Sir,

I beg to acknowledge the receipt of yours covering a draft value £30 being the Premium for the high pressure of steam on the first steam carriage.

I called on Mr. Murray the other day and find they are going forward with your engines. He tells me Mr. Brandlings engine will be completed in a fortnight (say 3 weeks) and then yours will go rapidly forward. If you can manage to pay for the engine by February it will be equally suitable to me as Xmas as Mr. Brandling generally examines my Books the latter part of that month. I am sorry to hear from Mr. B. that you dont work the carriage. I hope you have got leave to cross the turnpike.

I am also happy to hear that people are making enquiries about the patent carriage. I hope you are so satisfied as to its reliability that you will be able to give a favourable report of it. I shall beg the favour of your favouring me with the address of the Duke of Portland's Agent with the heads of his enquiries and your observations upon them so that we may not differ in opinion should we be consulted.

I do not think, by the by, that either Chapman or Hedley will succeed in their mode of conveying goods. Shall I beg the favour of your sending me the rough draft of the agreement as I think I left with you Mr. Smith has asked for it.

I am dear Sir
Yours very truly
J. BLENKINSOP."

From this it appears that the engine was stopped, probably on account of the need for repairs mentioned in the previous letter, and there was also a difficulty in obtaining permission to cross the turnpike road which intersected the wagon way.

The reference to the Agent of the Duke of Portland is interesting. He had evidently been inquiring of Watson about Blenkinsop's system, no doubt with a view to employing it on the Kilmarnock and Troon wagon way, on which, however, one of George Stephenson's engines was subsequently tried. A copy of Watson's letter to the Agent, John Bailey, exists and runs as follows :—

Willington, 11th. Octr. 1813.

" Dear Sir,

In reply to your favour of the 6th. inst. I shall have at all times great pleasure in affording to his Grace the Duke of Portland & also to you every information in my power respecting the New Mode of Leading our Coals by Means of Steam Engines instead of Horses.

The Engine which is used is considered of Four Horses Power, of Trevithick's Invention, being the most powerful one we have in use at present, and is made by Messrs. Fenton, Murray and Wood of Leeds, or any other Engine Builders, and costs £380 including £30 paid to Trevithick for his Patent. This Engine is so constructed that by the operating Aid of Cranks which turn a Cogged wheel working in Metal Cogs cast upon one Side of the Rail laid and also used as the Railway thus (sketch of rail) by which a considerable Power is given to the Machine : A power so considerable, that when the Machine is lightly loaded, it can be propelled at the Rate of Ten Miles an Hour ; but when properly loaded is calculated to go at the rate of from 3½ to 4 Miles a hour upon a *Level way* which we find to be the speed best suited to the Engine.

The experiments which has hitherto been tried have given the greatest Satisfaction and promise to be attended with the most beneficial Effects. It is supposed and indeed I think with a tolerable degree of Correctness that ⅝ths of the Expence of Leading the Coals by Horses will be saved by the Invention, as I find it has cost us at Kenton 2/- p. Chaldron Leading our Coals to the River by Horses / a distance of 5½ miles / while I am satisfied as soon as we get our way completed to the River it will not cost us more than 4d per Cha. conveying them by Mr. Blenkinsops mode ; Consequently as our Leadings from that Colliery are about 36,000 Chas. a Year, we presume we shall save at least £3,000 p. annum at that Concern.

At Leeds they have been daily at work for some time back Leading their Coals in this way, and as their Way is perfectly level their Engines take with great ease 24 Nineteen-boll Waggons loaded at a time,—each waggon weighs with its Contents about 3½ tons, making together an aggregate weight of 84 Tons, in addition to which the weight of the Engine of itself is nearly 5 Tons.

The result of our Experiments at Kenton has been that the Engine is capable of drawing 16 Twenty-four-boll waggons each Journey, which we compute will weigh with the Coals therein 64 tons, in addition to the weight of the Engine as before stated. And had our Rail-way been upon a Level, the same as Mr. Brandling's at Leeds, there would have been no doubt of our taking the same weight each Journey as they do ; but owing to an Ascent of Ground for a considerable distance from the Pit along our Rail-road we deem'd it prudent not to load the engine with more than the weight above specified. The Number of Men necessary to be employed in both instances has been two yet they frequently have only one at Leeds, nor do I think it absolutely necessary to have more where the Line of Rail-road is perfectly level.

In Regard to the Expence of making the Railway suitable for the conveying the Coals by the Steam Engine you will readily conceive as the Engine itself is of the greatest weight that will bear at any one time upon each Rail, it will be necessary to have the rail of such a Strength as will resist its weight without Risque of breaking. I have therefore made our way at Kenton of the following Strength, and which in my opinion is not too strong, altho' Mr. Brandling's at Leeds is not near the weight, consequently cannot be the Strength.

One yard of the Cogged rail upon the Kenton way weighs		60 lb.
The Chair or Pedestal for do :	weighs	20
		80
One yard of the Common rail used on the offside weighs		36 lb.
Chair or Pedestal for Do		14 50
Total weight of one yard of way at Kenton and Coxlodge Colly.		130

The weight of one yard of Common Railway necessary to be laid for leading the coals by horses is 100 lbs. including the Chairs or Pedestals, consequently there is an addition of 30 lb. weight of Metal per yard, between the common Rail Road and the one adapted for the use of the Engine which you will see arises by the addition of the Cogs being cast on the side of the Rail.

The Rails and Pedestals being of such a weight, I estimate that a yard of way will cost making as under.—

	lb.	lbs.	s. d.
1 yard of Cogged Rail & Pedestal	80	130 @ 15 per cwt is	17—6
1 do of Common Rail & do ..	50		
1 sleeper			2—3
Workmanship laying the same			0—6
Ballasting etc.			0—8
Nails			0—1
		Per yard ..	£1—1—0
A yard of Common way will cost Laying with Metal stating the weight of the 2 Rails and 2 Pedestals at 100 lbs as above, including Sleepers, Laying, Nails, etc.			17—0
			£0—4—0

which will be 352£ per mile, additional expence between the two ways.

With respect to the formation of the Railway it is not absolutely necessary that it should be a Right line, yet as many Turns as possible should be avoided, but when under the necessity of making one, I think the Curve should not exceed 1 in 10 where forming the turn, provided 16 or 18 waggons are attached to the Engine : I consider it of more consequence in forming the way to endeavour to keep it level, than keeping it in a straight line.

Should the Length of Lead from his Lordship's concerns in Ayrshire be considerable, I have no doubt but a considerable Saving will be made, by adopting Mr. Blenkinsop's new Method ; and should have great Pleasure in giving my Opinion therein, or any further information you may require on the Subject.

and Remain, Dr Sir
Yours most respectfully
JOHN WATSON.

P.S.—It is necessary to state to you, that Mr. Blenkinsop has not altogether fixed upon what principle he intends charging for using his invention, therefore could not state it in the Expence of the Leading ; but I understand he has agreed with some Gentlemen in Wales lately, that he should receive £50 per annum, for each Mile of way they use his Invention,—Consequently upon a Line of way 5 Miles Long he would be entitled to £250 per annum.

JOHN BAILEY Esq. "

This is an extremely informative letter and shows, amongst other things, that the rack rails then in use were a yard long, with six hollow teeth, and rested on chairs. The weight given agrees with that of the modern castings made from some old patterns found at the Tyne Ironworks in 1870, and supposed to have been those from which the original Kenton and Coxlodge rails were cast. The modern chairs cast from the old pattern are, however 50 per cent. heavier than Watson's figure. The name of the Tyne Iron Company occurs in a Kenton and Coxlodge account as a contractor for rails and chairs.

The last letter of the series dates thirteen months later, and is from Blenkinsop to Watson.

Middleton, 18th. Nov. 1814.

" I have received a letter from Mr. West respecting the Premium of the two last engines and as he wrote to Mr. Murray that he only charges £10 for an engine of four horse power, I think it will be desirable to pay him the £20 for the two and be done with him. I have wrote to West and stated that I did not intend to pay him any further Premium as I considered my patent was no way connected with their Grant.

I have been told that the Coxlodge Managers are going to adopt the Killingworth plan of conveying their coals and I beg the favour of your informing me whether there is any truth in the information or not, I shall also be obliged if you will inform me whether the Fawdon owners intend to adopt the Killingworth plan or mine. Do you think the Killingworth engine will travel up hill or on a level during wet or frost.

yours truly,
J. BLENKINSOP.

This clearly shows that Watson's two engines had been completed before the date of the letter, and that their user had to pay royalties under both Trevithick's and Blenkinsop's patents. Blenkinsop was evidently beginning to fear the effect of the introduction of George Stephenson's adhesion engine on the prospects of his own plan.

The Kenton and Coxlodge locomotives continued to work until May, 1815, apparently with perfect satisfaction, as a viewer's report dated May 9th of that year says :—" The method of leading coals by the aid of the steam engine lately adopted we certainly think preferable to the former plan of leading by Horses and we are further of opinion that if the waggon road suited for this purpose were completed as far as originally intended, the saving on the leading of the quantity calculated upon, viz., 33,000 chaldron, will not be less than £1,200."

The engines were laid aside, apparently on account of some trouble between Watson and his partner Samuel Williams, who had a large interest in the Fawdon Colliery, which used the same wagon way, but still depended on horse haulage. Later on Watson claimed £2100 from Williams as his " loss by laying off the travelling engines from May, 1815 to Lady Day 1817." A Kenton and Coxlodge Colliery stock list of December, 1814, contains the item : " Travelling engines and Horses £734, 18, 8," which could only cover two engines, but the list for December, 1815, does not mention them.

Although there is little evidence on the point, it would appear that Watson's first engine, that is, the one lent him by Blenkinsop, was returned to Leeds. It was, by Murray's evidence, smaller than the later two that he made for Watson, and would on that account be less useful. The evidence clearly shows that Murray made six engines for Blenkinsop and Watson before the end of 1814.

What became of Watson's two engines after May, 1815, is not certainly known, but there is a possibility that they returned to work after March, 1817, either on the Kenton and Coxlodge ways or at Willington.

From Blenkinsop's letters it appears that he was in treaty with several persons about the use of his rack system, and had actually come to terms with some. Whether his system was actually employed at any other collieries than those mentioned by Blenkinsop in his statement to Sir John Sinclair, in 1814, is not definitely known, but it is possible that some of the engines which are believed to have been built elsewhere about this time were, in fact, rack engines made under his licence.

The engines at Orrell Colliery, near Wigan, have long been a mystery, as, while George Stephenson said, in his evidence on the first Liverpool and Manchester Railway Bill in 1825, that he had seen the engines at Wigan, yet none of the early writers on the locomotive so much as mentions them. It appears, however, from a letter published in Newton's Journal, that in March, 1822, there were three rack locomotives at work there, two being in constant use and the third in reserve. Each engine weighed 7 tons, including 1 ton of water, but it only hauled nine coal wagons weighing 3 tons each loaded, or a total of 27 tons, at a speed of 2½ miles an hour. This comparatively small load may have been due to considerable gradients on the line.

Although it at one time appeared possible that the Coxlodge engines might have been transferred to the Orrell line after May, 1815, yet as the recorded weight of those engines was only 5 tons, it is unlikely that they could have been the same engines. In any case at least one of the Orrell engines must have been built before the end of 1814, but who built them is still unknown, or how long they remained at work.

Obituary.

H. L. CALLENDAR.

CAMBRIDGE REMINISCENCES.

By SIR RICHARD GLAZEBROOK.

CALLENDAR entered Trinity College, Cambridge, in October, 1882, from Marlborough. The following year he was elected to a Bell Scholarship along with Dr. M. R. James, now Provost of Eton, after an examination specially, but not of necessity exclusively, in classics and mathematics. In due course he became a scholar of the College. In 1884 he was placed in the first class of the Classical Tripos. The following year he took his B.A. degree as a Wrangler, First Class in Mathematics, and in October, 1886, he was elected a Fellow of Trinity for his experimental work in natural science. This brief record is perhaps sufficient to show his extraordinary brilliancy in his student days.

The fellowship dissertation with some added work was published by the Royal Society in the "Philosophical Transactions" for 1887. It was read in June, 1886, when its author was still a B.A. scholar of the College. Its title is "On the Practical Measurement of Temperature," and it records the birth of the platinum thermometer as an instrument of precision. Siemens some years before had called attention to the possibility of using the temperature variation of the resistance of platinum as a means of measuring temperature, and the Siemens pyrometer was a well-known instrument; but a B.A. Report made in 1874 had been adverse to its employment for accurate work, and J. J. Thomson suggested to Callendar in 1885 that the question was worth a fuller investigation.

The result was a remarkable paper, remarkable it would be as the work of a practised physicist; as the first effort of a boy of twenty-three, with no laboratory experience, it is great. At the time I was Demonstrator and well remember the experiments, carried out with some difficulty on the broad stone window of one of the lower rooms of the laboratory, a space that was rather a passage leading to the room in which Lord Rayleigh had made his electrical experiments and where the Professor himself was engaged on his early work on the electric discharge and the passage of electricity through gases. My own work on electrical standards was in progress in the next room. Callendar worked alone; we could not help him much, not that he needed our help. Such requisite apparatus as was available was put at his disposal, and he acknowledged the assistance received from the laboratory mechanic, "though owing to the many calls on his time he was unable to make much of the apparatus. I had intended to make many other experiments, but my progress has been much retarded by my own want of mechanical skill and the necessity of making all my own apparatus."

It is worth while to quote his statement of the qualifications of a standard for the measurement of temperature :—

(i.) Such a standard should always give the same indication at the same temperature, should be free from secular change of zero, and should possess the widest possible range.

(ii.) It should be portable and easily copied so that standards might be multiplied, and, if the original were lost, it might be replaced by means of its copies. The copies should be capable of accurate comparison and verification.

(iii.) It would be convenient if it agreed very approximately with any standards already in use, and if, failing this, the relation between the new and pre-existing standards could be accurately ascertained.

(iv.) It would be a great additional advantage if besides being useful as a standard it could also be applied directly to all kinds of practical investigations.

And then he sets to work to test one by one how far a platinum resistance thermometer fulfills these qualifications. The standard method of temperature measurement he adopted was that afforded by the constant volume air thermometer, and his platinum thermometers were spirals of a very pure platinum wire sealed into the bulb of the air thermometer. Nowadays his paper may seem long and unnecessarily detailed, but he had a difficult case to prove, and so the data are given in full, and the reader who has the patience can verify his results himself.

The platinum temperature pt is defined as the function $100\ (R/R_0-1)/(R_1/R_0-1)$, where R_1 and R_0 are the resistances of the spiral at 100 deg. Cent. and 0 deg. Cent. and R its resistance at temperature $t°$ as given by the air thermometer, and then he shows that his observations are seen to agree fairly well with the parabola

$$d = t - pt = \delta\,[(t/100)^2 - (t/100)],$$

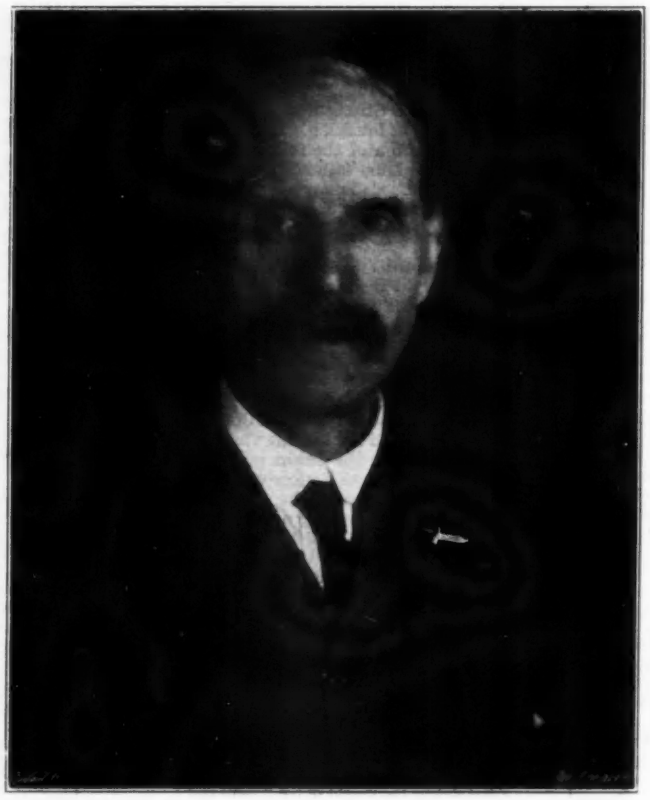
where in his experiments δ has the value 1·57.

Later experiments with Griffiths showed that the value of δ depended on the purity of the wire used for the thermometer, but that, provided the proportion of impurity was small, the formula held, so that the temperature t on the air scale could always be obtained from the resistance of the wire if the three constants R_0, R_1 and δ were known. The instrument needed calibration at three points, and for the third point the melting point of sulphur was chosen and the method of making the determination laid down. Callendar's work covered the range 0 deg. Cent. to 600 deg. Cent., and his formula has stood the test of time. In those days the Kew Committee of the Royal Society was the standardising authority for thermometers in England, and after correspondence with the Bureau International des Poids et Mesures it was arranged that Dr. Harker, who had been experimenting with apparatus set up in 1895 at Kew under the supervision of Griffiths, should go to Sévres in order to compare, in co-operation with Chappuis, Savant Attaché au Bureau, some platinum thermometers belonging to Kew with the standard instruments of the Bureau. The results of the comparison are given in a paper in the "Philosophical Transactions" for 1900 and fully bear out Callendar's claims. In the end, to make a long story short, an international temperature scale was agreed to by the General Conference of Weights and Measures, 1927, when the platinum thermometer was adopted as the standard from ice point up to 660 deg. Cent.

To quote the report :—"(8) From the ice point to 660 deg. Cent. the temperature t is deduced from the resistance R of a standard platinum resistance thermometer by means of the formula $R_t = R_0\,(1+A\,t+B\,t^2)$. The constants R_0, A, and B of this formula are to be determined by calibration at the ice, steam, and sulphur points respectively." And then follow certain limitations as to the purity of the platinum.

To conclude, a comparison has been made during the past year and is published in the "Philosophical Transactions," Vol. 129, between the platinum thermometers of the N.P.L. and fifteen mercury in "verre dur" thermometers calibrated by the Bureau International, on which the standard scale in use at the Laboratory has been based, with the result that the change to the resistance thermometer will not alter the scale at the Laboratory by more than 0·002 deg. Cent. between 0 deg. and 50 deg. Cent. or by more than 0·005 deg. Cent. between 50 deg. and 100 deg. Cent.

Could any more conclusive proof be given that the platinum thermometer has the qualifications necessary for a standard laid down by Callendar in his earliest paper forty-five years ago? But I have wandered far from Cambridge reminiscences and there is not much more to say. For a short period in 1887–88 he helped me as Assistant Demonstrator, but in 1888 he became Professor at the Royal Holloway College, which he left when elected to the Professorship of Physics at Montreal in 1893. His well-known work on the Flow Calorimeter"—"Phil. Trans.," 1902—belongs to this portion of his career, but is directly connected with Cambridge days. "The method of continuous calorimetry," he writes, "was originally devised as part of a fellowship dissertation on applications of the platinum thermometer at Trinity College, Cambridge, in the year 1886, but on account of unforeseen difficulties did not at that time get beyond the preliminary stage." It is given to few men at the age of twenty-three to devise two such far-reaching inventions as the platinum thermometer and the method of continuous calorimetry.



PROFESSOR H. L. CALLENDAR.

HIS WORK FOR ENGINEERING.

By PROF. W. E. DALBY.

Professor Hugh Longbourne Callendar died on January 21st, 1930, after a brief illness, and his work for us is done. The whole engineering profession will offer sympathy to Mrs. Callendar and to his family. Though we all recognised Callendar as a genius moving in altitudes of thought denied to most of us, yet he was such a lovable character, so simple minded, and so ready to help that we forgot the genius and remembered only the man and the friend.

To the world at large Callendar is known as a physicist. To our own engineering world he is looked upon as one of ourselves. We have appropriated him. Working in a small laboratory in Montreal, he and an engineering colleague tackled the subject of the condensation of steam in an engine cylinder. Adapting his methods of thermometry to the problem of measuring the rapidly changing temperature of a cylinder wall, he was able to compare the change of temperature of the wall with the change of temperature of the steam in contact with it. This led to real knowledge of the action of steam in the cylinder and to the true explanation of the higher efficiency of compound expansion, notwithstanding the losses inevitably incurred as the steam is transferred from one cylinder to another. The work was presented in a paper entitled "Condensation of Steam," read at the Institution of Civil Engineers during the session 1897–98. The leaders of the profession were at the reading and took part in the discussion. The manner of its reception is well shown by one sentence which fell from the lips of Dr. Unwin, happily still with us. Dr. Unwin said :—"The paper was really a gift to the engineer from the laboratory." And so it has proved. The most recent investigations relating to the temperature gradients in the cylinder heads and pistons of large internal combustion engines have been carried out by what is substantially Callendar's method.

Apart from the particular problems of temperature gradients in engine cylinders, Callendar developed to a fine art the measurement and recording of high temperatures by platinum thermometry. Some form of the Callendar recorder will be found in all places where an accurate record of temperature is wanted, either high or low. His work on thermometry is a gift, not only to engineers, but to workers in all branches of science.

His most recent work is in relation to the Steam Tables. Until comparatively recently the Steam Tables used by engineers were based upon data found experimentally by Regnault and published in the "Memoirs" of the Institute of France in 1847. The columns and rows of figures under the eye in the older Steam Tables were based substantially on experiment and extrapolation from experiment. The variation of the latent heat of steam and variation of its saturation and other properties were generally expressed by purely empirical formulæ without theoretical foundation. Callendar, in a paper published in the "Proceedings" of the Royal Society on June 21st, 1900, entitled "On the Thermodynamical Properties of Gases and Vapours as Deduced from a Modified Form of the Joule-Thomson Equations, with Special

Reference to the Properties of Steam," stated that "the object of the present paper is to develop the application of a modified form of the Joule-Thomson equation, which is sufficiently simple to be of great value in the discussion of the thermodynamical relations of gases and vapours and which leads directly to accurate formulæ for many properties which have hitherto been represented empirically."

And so began his great work on the properties of steam, work which continued up to the time of his death.

His original Steam Tables and equations published in 1900 represented the first thermodynamically consistent system devised for the tabulation of the properties of water and steam. In 1920 he published a fuller table, commencing at one-tenth of a pound per square inch and going up to 500 lb. per square inch, in his book "Properties of Steam and Thermodynamic Theory of Turbines." The enlarged Callendar Steam Tables appeared in 1924. These tables were based on a characteristic equation devised by Callendar, which included a term *c*, which he called the co-aggregation term, and it was treated as a function of the temperature only. The figures of the tables were well below the critical region.

In 1928 another remarkable paper of fundamental importance was published by Callendar in the "Proceedings" of the Royal Society, entitled "Steam Tables and Equation, Extended by Direct Experiment to 4000 lb. per Square Inch and 400 deg. Cent."

A modification of the co-aggregation term, calculated now by means of a series which made it a function of the pressure as well as the temperature, enabled him to explore the critical region with success. With the modified values of *c* and a new value of the constant *b* he re-calculated a skeleton steam table. The first paragraph from his paper "Extended Steam Tables" to the Institution of Mechanical Engineers, May, 1929, gives in his own words the position at that date. He said :—"With the assistance of the British Electrical and Allied Industries Research Association it recently became possible to make direct measurements of the total heat of both water and steam at pressures up to 4000 lb. per square inch and temperatures up to 750 deg. Fah. These included the whole of the critical region, in which no heat measurements had previously been made, and proved that the objection to the Joule-Thomson equation (namely, that it was incapable of representing the complex phenomena of the critical state) had no foundation in fact. The new experimental data proved to be quite inconsistent with the van de Waals theory, which had universally been accepted for more than fifty years, but fell naturally into line with the fundamental basis of the Joule-Thomson equation, as first applied to steam by the Author in 1900."

A set of skeleton tables calculated from the modified equation was forwarded to the Research Association in 1928. The British Electrical and Allied Industries Research Association convened in 1929 in London a conference of physicists and engineers engaged in work on the properties of steam. The conference held its first sitting on Monday, July 8th. Chief among the representatives of Great Britain was Professor Callendar. Starting with a paper to the Royal Society in 1900, his work had become of international importance in 1929. He was a great and distinguished figure at the conference, and its meeting and his colleagues were proud of him.

This brief account of his work from the angle of an engineer is woefully incomplete. It will occupy many specialists in different departments of physics many months to marshal the work of his lifetime into a related whole. We are at present too close to his achievements to fully appreciate his genius, but it is a safe prediction that the scientific men of future generations will place few names as high as Callendar's in the hierarchy of great physicists.

Books of Reference.

"GARCKE'S Manual of Electrical Undertakings and Directory of Officials." Vol. XXXII. London: The Electrical Press, Ltd., 13–16, Fisher-street, Southampton-row, W.C. 1. Price 35s. net.—The 1930 "Garcke" contains the accounts of the various electricity supply undertakings issued during the period 1928–29—that is to say, the latest available—and the other information has been corrected up to the end of September, 1929. Two new features have been embodied in this year's volume. First of all, to the "Progress Section" have been added brief particulars of new generating stations sanctioned, and under construction. It is hoped that this addition will prove of value as indicating modern power station equipment. Then, too, the "Contractors' Section" has been amplified, so that it now contains every town and area in which supply is available and the name of the supply undertaking. A comprehensive list of this kind should be most useful. The details of the areas actually supplied have also been included in the data of each undertaking in Section I. For the rest, the "Manual" follows closely the lines of those that have preceded it, and "Garcke" is too old a friend now to need any word of commendation or explanation from us.

"CONCRETE Year Book, 1930: A Handbook, Directory, and Catalogue of Concrete." London: Concrete Publications, Ltd., 20, Dartmouth-street, Westminster, S.W. 1. Price 3s. 6d. net.—This useful book of reference, now in its seventh year of issue, has been enlarged so that, with its catalogue section, it now runs to over 680 pages. The Handbook Section, which extends to 200 pages, contains much information concerning every-day use which is likely to prove of value to those concerned with civil engineering and constructional work. Then, there are chapters giving tabulated designs, illustrated by diagrams, of foundations, floors, walls, beams, columns, and other building members intended to carry various loads. Concrete making and placing, reservoirs, water towers, roads, bunkers, silos, pre-cast concrete, sewers, culverts, &c., are other subjects that are dealt with. The Directory Section contains a directory of the concrete and allied industries, with a list of trade names and brands, with the names and addresses of their proprietors. In the Catalogue Section there are some 350 pages dealing with the businesses and products of firms engaged in the concrete industry or supplying plant and materials for constructional work. This part, it is claimed, forms a complete guide for those in need of a contractor to carry out specialist work or to supply machinery and materials for particular purposes.

"THE Colliery Manager's Pocket Book, Almanac, and Diary for the year 1930." London: The Colliery Guardian Company, Ltd., 30 and 31, Furnival-street, Holborn, E.C. 4. Price 3s.—This year's volume, which, by the way, is now in the sixty-first year of publication, contains, as usual, an almanac for the year, a diary, &c., which are followed by chapters on mining progress during 1929; mining statistics; coal and its by-products; valuation; depreciation; surveying; mine ventilation; rescue and ambulance; strength of materials; machinery; explosives; approved safety lamps; electricity in and about mines; inspectors of mines; information for candidates for certificates, &c.; and particulars of examinations. Then, there are lists of Government offices, Departments and Committees, Mining Institutes, Trade Societies, &c. The book still preserves its customary form and size, and will without doubt be welcomed by those for whom it is especially intended to assist, as heartily as have been those which have gone before it.

"THE *Practical Engineer* Mechanical Pocket Book and Diary, 1930." London: Humphrey Milford, Amen House, Warwick-square, E.C. 4. Price 2s. 6d.—In this year's volume, we are told in the Preface, such amendments as seemed necessary or desirable in view of recent developments and research have been effected, while new notes to a considerable volume have been introduced, and many retained from former editions have been condensed, amplified, and rearranged. Among the new notes which are considered to be perhaps the most important are those dealing with steam traps, reducing valves, steam control valves, water-tube boilers, Diesel and other oil engines, both land and marine, and the British Engineering Standards Association. It is hoped, too, that reference between text and illustrations in the notes on Engine Indicators and Indicator Diagrams will be found much more easy and convenient by reason of the rearrangement which has been effected for that purpose. The present volume is, it may be added, the forty-second edition of this handy and useful little book of reference.

"THE *Practical Engineer* Electrical Pocket Book and Diary for 1930." London: Humphrey Milford, Amen House, Warwick-square, E.C. 4. Price 2s. 6d.—This little book is now in its thirty-first year of issue. Of late years, we are informed by the editor in a foreword, there has been a tendency for it to expand into dimensions not commensurable with those of the pockets of the ordinary man. This year, therefore, a careful revision has been made of the contents of the volume with the object of producing a more compendious work. The reduction in size, if there has been any, however, does not appear, from our examination of it, to have robbed the book of any of its usual features, nor to have detracted in any way from its usefulness. In the revision, the section relating to Lighting has been rearranged, and it now includes fuller information than has hitherto been given regarding cinema lighting. Then, too, the Tables from the Wiring Regulations of the Institution of Electrical Engineers have been redistributed to the section to which they are most appropriate. As usual, there is a diary at the end of the book, and short dictionaries of technical terms in French, Spanish, and Russian.

"THE South American Handbook, 1930." London: Trade and Travel Publications, Ltd., 14, Leadenhall-street, E.C. 3. Price 2s. 6d. net.—This little book, now in its seventh year of issue, claims to be the only annual handbook to a continent which is changing and progressing rapidly and to be "South America in a Nutshell." It certainly contains a large amount of information regarding the various countries of the continent, and some beyond its confines—for instance, the states of Central America and Mexico. The information is of a comprehensive type, and by no means all of it is of special interest to engineers; but a good deal of it is, especially that dealing with physical features, forest produce, mineral resources, railways, transport, &c. The book is well arranged and printed, and should certainly prove useful to anyone proposing to visit what is known as "Latin America." Its utility is enhanced by an excellent index.

THE ORPINGTON BY-PASS ROAD.

ON January 22nd, the new bridge constructed for the Kent County Council and carrying the main London–Dover line of the Southern Railway over the Orpington by-pass at St. Mary Cray, Kent, was opened for traffic. The Orpington by-pass forms the last item in Kent of the programme of road works initiated in the autumn of 1923. The greater part of the road had been open to the public since June 26th, 1927, but short lengths adjacent to the new bridge had been closed to through traffic owing to the bridge works.

The Orpington by-pass is 6¼ miles in length and forms, together with Cray-road at its northern end, widened by the Kent County Council, a switch road between the London–Folkestone road and the London–Hastings road, from Sidcup and The Crays in the North to Chelsfield and Polhill in the South. It will now be possible for traffic from East and South-East London to proceed *viâ* the Blackwall Tunnel, Kidbrook Park-road, the Eltham and Sidcup by-passes and the new road to Sevenoaks, Tonbridge, West Kent and East Sussex. The effective width of the new road is 80ft., made up of a 30ft. central carriageway, with one footway and two verges, on which latter trees have been planted throughout the whole length. The carriageway is constructed with concrete as its running surface; natural stone kerbs have been employed throughout.

The earth works were light in character, the northern end of the road being on alluvium and gravel in the valley of the river Cray. After crossing Orpington High-street the road mounts up to Chelsfield, mainly on the chalk sub-soil, which is characteristic of that part of the country.

The new bridge replaces an old brick arch, 24ft. in span, constructed by the London, Chatham and Dover Railway Company many years ago to carry an accommodation road under the high embankment immediately East of St. Mary Cray Station. The effective span is 60ft., and the steel girders are designed to carry two railway tracks. The mass concrete abutments have been constructed of sufficient length to take three extra tracks when so required by the railway company.

The earth works and drainage of the road were carried out by Sir W. G. Armstrong, Whitworth and Co., Ltd., while Messrs. Fordyce Brothers constructed the concrete carriageway and pertinent works. Sir Lindsay Parkinson and Co., Ltd., built the bridge under the supervision of Sir E. Owen Williams, K.B.E., M. Inst. C.E., Consulting Engineer to the Ministry of Transport, who has had the advice of Mr. Maxwell Ayrton, F.R.I.B.A., in the preparation of architectural details.

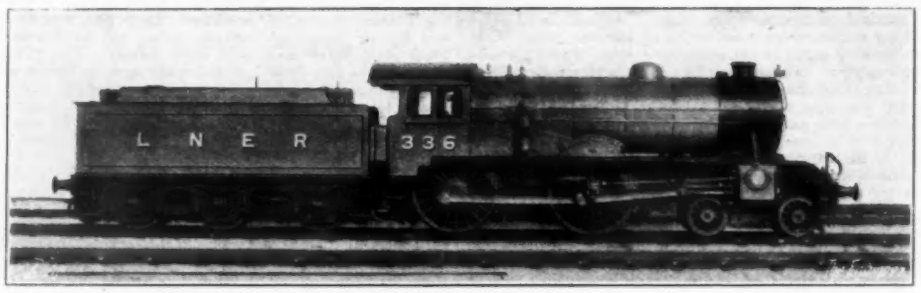
The total cost of the road, including the bridge, is estimated at approximately £310,000, towards which the London County Council have contributed 25 per cent. in consideration of unskilled labour from the County of London being employed on all the works.

SIXTY YEARS AGO.

THE Victorians were undoubtedly on frequent occasions careless in the matter of preserving the amenities of urban and rural life. In their pursuit of convenience and commercial advantage they were at times indifferent or blind to the æsthetic and even the hygienic effect of their undertakings. We are supposed to possess increased enlightenment in this direction to-day. Philosophers rejoice in the awakening of the public conscience to the fitness of things which they claim to detect in the opposition which has been raised to the construction of the power station at Battersea, in the interest which is being taken in the Charing Cross Bridge scheme, and in the efforts which are on foot to save the countryside from spoliation. We have, however, more than a doubt that, apart from a relatively few leaders of thought, the general public is still largely or wholly unconcerned about the preservation of beauty in its surroundings, and is still prepared to accept with equanimity the erection in its midst of ugly buildings and the carrying out of unsightly schemes in unsuitable situations. Nor can we console ourselves with the reflection that if there has been no real growth in public feeling as regards these matters, the voices now raised in protest by a lively few at least represent a new phenomenon. In the 'sixties of last century they had their Battersea power stations, or, more correctly, gasworks at Fulham, and a strenuous and effective opposition to their erection, led by the Bishop of London and eight of his brethren. Plans for extending the gasworks at Westminster were equally successfully opposed. When some of the companies—there were thirteen of them serving the London area in those days—proposed to erect new works at Bow, they were told that if they were allowed to do so they would spoil the atmosphere of Victoria Park. In something which seems to have approached a spirit of desperation, the companies issued a veiled threat that if concessions were not made to their needs parts of London would be left in darkness. Not only were the companies effectively opposed as regarded the choice of site for new works; a strong agitation developed in favour of their being amalgamated or of transferring their powers to a public body. The companies opposed any such move, in spite of the fact that their respective areas were cut up and separated in an arbitrary and obviously most inconvenient manner. Still further troubles were, however, in store for them, for in 1867 Parliament adopted a policy of refusing to consent to any Bill promoted by a gas company unless the company agreed to certain terms regarding the price and illuminating power of its gas. In 1868 the Gas Light and Coke Company—which in those days served two distinct areas, one in the West End and the other in the City—agreed to accept the conditions imposed by Parliament in order that it might proceed with the extension of its undertaking. Foiled at Bow, it sought a site for a new gasworks farther down the river, near Barking Creek, an area to which no one appears to have objected, probably because it was already possessed of the great northern outfall sewer. The land chosen was so isolated that no roads existed whereby to reach it, until the company made one for itself. It had not even a distinctive name, but Mr. S. Adams Beck was the governor of the gas company at the time, and in his honour it was called Beckton. Thus came into being the great gasworks which we know so well to-day. In our issue of February 4th, 1870, we announced that they were rapidly approaching completion, and began a detailed description of them.

A TUNNEL 6ft. in diameter by 600 yards long is being made under the river Hooghly to accommodate electric cables between Calcutta and Howrah. It is to be at a depth of 93ft. below the river bed.

L.N.E.R.—LOCOMOTIVE WITH LENTZ VALVE GEAR



Lentz Locomotive Valve Gear.

Two 4-4-0 type three-cylinder express passenger locomotives, Nos. 336 and 352, of the London and North-Eastern Railway, have recently been fitted with a rotary cam poppet valve gear supplied by Lentz Patents Ltd., and illustrated herewith. This arrangement is known as the "R.C." (rotary cam) poppet valve gear, and consists of a cam shaft which obtains a rotary motion by means of suitable gears and shafting so arranged that the rotation of the cam shaft can be synchronised with that of one of the coupled axles.

As applied to the locomotives in question the cam shaft is placed above the cylinders with its axis at right angles to the horizontal centre line of the locomotive. It is made of high tensile steel, and has mounted on it specially formed stepped cams arranged to control the steam admission and exhaust valves for each of the three cylinders.

The steam inlet cams for each cylinder are made in two separate sections. Those for forward gear running provide for five different rates of admission ranging from a minimum cut-off of 15 per cent. to a maximum of 75 per cent. in full gear; whilst for back gear running a further set of cams is used which gives two rates of admission, one for full gear and the other giving a shorter rate of cut-off of 35 per cent.

In addition, there is provided a cylindrical cam for each cylinder for the purpose of closing the steam valves when the engine is placed in "mid gear," in which position the exhaust valves are held open by a similar cam of larger diameter in the exhaust set.

The arrangement of the exhaust cams is somewhat similar, but only three different profiles are provided. They are designed in such a way that when the engine is in full gear the point of compression starts later than is the case at the shorter admission rates. This arrangement permits of the ready discharge of the steam and assists in starting. Separate exhaust cams also enable the point of release to be adjusted to suit the cut-off, and in this instance release takes place at 90 per cent. in full gear and 80 per cent. for all other cut-offs.

There are four valves for each cylinder, two for admission and two for exhaust. Disposed between the cams and the valve spindles there are intermediate levers which are fitted with specially shaped rollers which bear against the cam profile. The method employed to impart the required rotary motion to the cam shaft is as follows:—At one end of the cam shaft is securely keyed a driving dog, which is fitted in a hollow sleeve, in the bore of which are cut suitable keyways engaging with appropriate projections formed solid with the driving dog. At one end of the sleeve and on its outer periphery is keyed a spiral bevel wheel. The object of this arrangement is to permit of the rotation of the cam shaft by means of the driving dog and at the same time allow the shaft to be moved in an axial direction for reversing.

The spiral bevel keyed to the driving sleeve engages in turn with another bevel wheel keyed to a shaft carried in a suitable bearing which is formed in the gear casing.

Extending backwards outside the locomotive is another length of shaft which is carried by a bearing bracket fitted with ball bearings and fixed to the right-hand outside cylinder slide bar bracket. From this point there is another length of shafting fitted at each end with standard Hardy-Spicer universal joints, a fixed joint being used at the motion bracket, and at the end next the main driving gear-box a slip joint is provided.

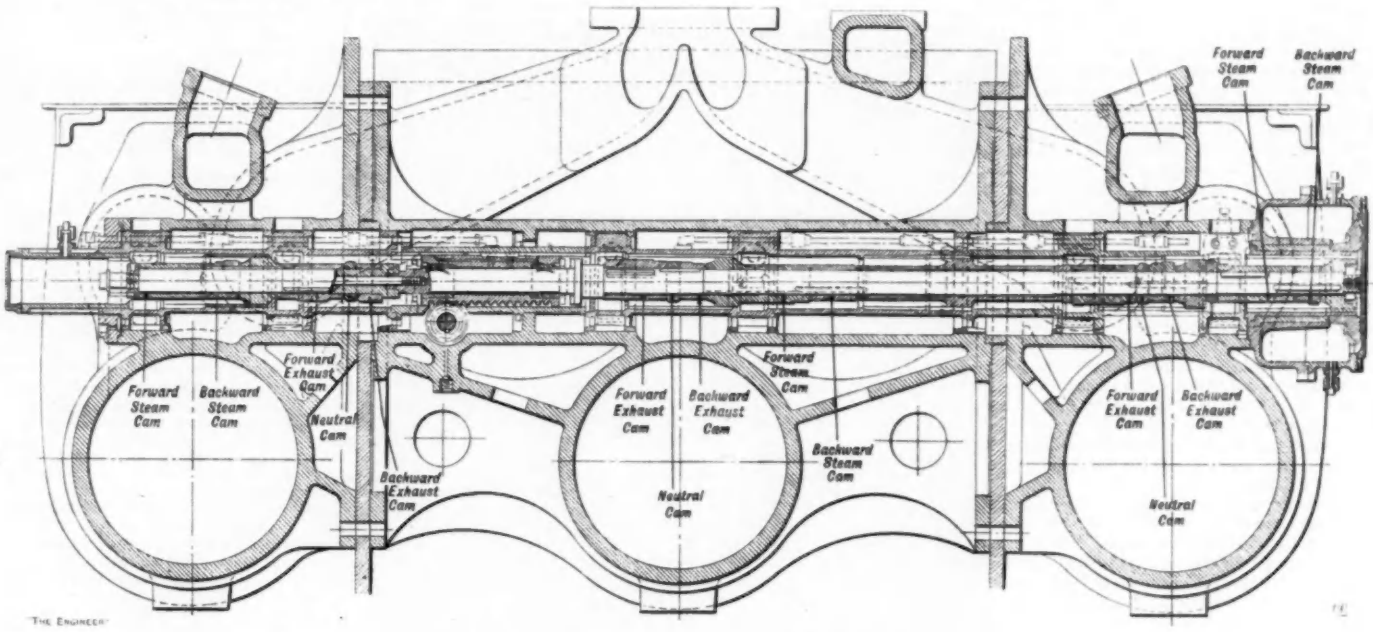
The main driving gear-box itself consists of two spiral gears mounted in a dust-proof oil-tight casing. The main driving wheel is keyed to a return crank arranged so that the axis of the pin corresponds with the axis of the main driving axle.

The gear-box is fitted with ball bearings throughout and held in position by means of an anchor link secured to the top of the casing and to a bracket attached to the side footplating.

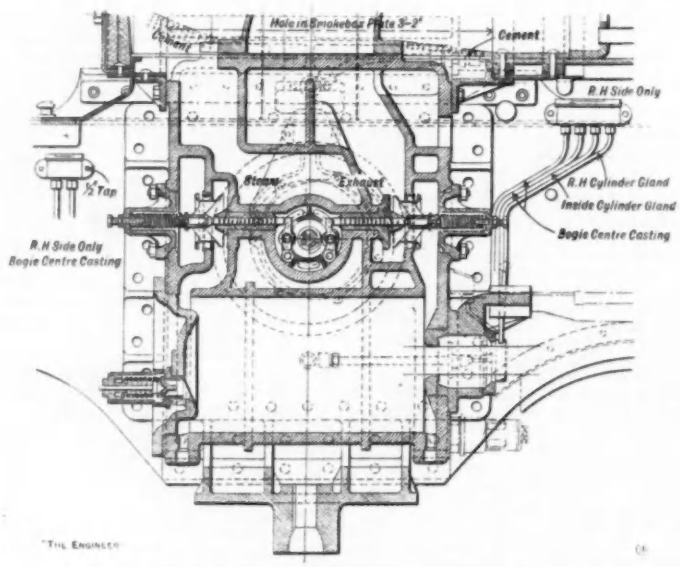
The reversing gear consists of the usual type of hand wheel fixed in the cab, the spindle of which is coupled to a shaft which runs along the boiler on suitable brackets to a bevel gear-box, and thence by a shaft which extends downwards to a self-locking gear-box, fixed to the inside of the main frame—which contains a pair of spiral gears. Thence a short shaft on the end of which is keyed a pinion gearing with a rack running on the cam shaft, passes into the cylinder casting. It is thus possible by rotating the hand gear in the cab to move the cam shaft transversely relatively to the locomotive centre line, and thus bring any cam at will into contact with the rollers on the intermediate levers. In this manner any cut-off provided by the cams may be employed, or, alternatively, the engine may be reversed.

Further, on the gear being put into its "mid" position, the steam valves are closed and the exhaust valves being held off their seats, an adequate by-pass is provided.

It is of interest to note that in the case of the engines under consideration the weight at the front end—that is, over the bogie—is lower by approximately 1½ tons as compared with the same type of engines fitted with piston valve cylinders.



CROSS SECTION THROUGH VALVE CAM SHAFT



SECTION THROUGH CYLINDER AND VALVE BOXES

High-Power Switchgear.

AT a meeting of the Institution of Electrical Engineers held on Thursday, January 23rd, Mr. L. C. Grant read a paper on "The Breaking Performance of High-power Switchgear and a New Form of Quenched Arc Switch." The difficulty of breaking the high short circuit powers of large modern systems has an important bearing on the security of electrical distribution. The oil switch as usually constructed is in some ways a fortunate device. As shown in the paper, the art of breaking a circuit under oil and thus bringing a high-temperature arc into contact with the oil results in pressures being set up which are not

necessarily dependent upon the actual circuit power being broken. It can be shown that even with fixed breaking conditions the formation of the arc and the oil pressure set up within the tank will vary. Such factors as the effect of phase angle, the influence of the layout of the system, and in another sense the speed of breaking and the effect of oil head have important effects upon the process of circuit rupture. The author has carried out an investigation in an attempt to assess the effect of these and other factors and to determine whether material improvement is possible without radical changes in design. The investigations have led the author to conclude that the fundamental limit of breaking capacity—that is to say, the short-circuit power which can be broken time after time by a given switch without breakdown—is, for the largest examples of present design of oil switches, rather below one million kVA, and that the present breaking capacity rating of oil circuit breakers is only correct if a certain factor of reliability is taken into account. For high-power breakers this factor, expressed as a percentage, appears to be about 96·5 per cent. and indicates that such circuit breakers can be relied upon in 96·5 operations out of 100, or, in other words, there is a 3·5 per cent. chance of breakdown. In order to eliminate this element of breakdown the breaking capacity rating should be divided by a factor which the author's tests indicate to be 2·5. Moreover, the limitations of the short-circuit currents by means of reactors may be

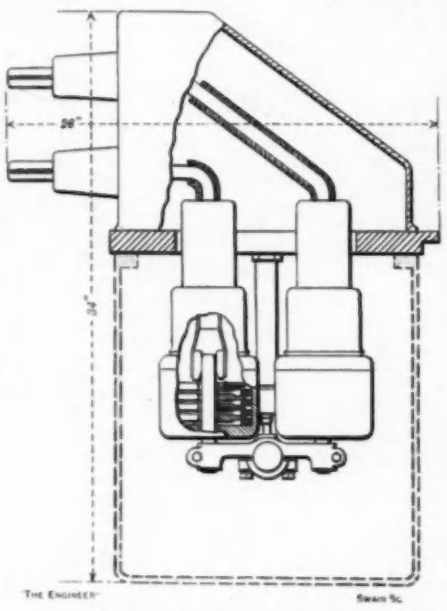


FIG. 1—ONE MILLION kVA SWITCH

responsible for troubles not hitherto identified with such a case. A circuit breaker embodying new principles has been evolved and tested under short-circuit conditions. Its performance is said to be superior to that of the usual oil switch, and a unit of given size and weight is capable of breaking many times the power broken by an ordinary oil switch of similar dimensions. Throughout the paper tests are quoted and illustrated by oscillograph records, wherever possible. The majority of the tests were carried out on a 6000-volt, 6000-kVA, 40-cycle alternator, but other tests were made at 11,000 volts with a 10,000-kVA, 25-cycle alternator, and at 6000 volts with a 25,000-kVA machine. The power used in these tests varied between 500 and 270,000 kVA. In all some 800 tests were carried out, in most of which such factors as periodicity, kVA and power factor were kept reasonably constant. Factors which could not readily be controlled were investigated by carrying out groups of rapidly repeated tests, from which a selection was made in such a way that the results bore directly upon the point being investigated. Although this may appear to be a rather roundabout method, it was found that groups of tests could be usefully co-ordinated and, for instance, results rejected from one group could be used in another group. In addition to this group of 800 tests, at least an equal number was available which, although not directly forming a part of the work described in the paper, were sometimes used for comparison. The switching apparatus consisted of several model switches, four being of an experimental character, whilst the remaining five were of a commercial or semi-commercial character. Compared with power station conditions the majority of the tests were carried out on a reduced scale, the switchgear being reduced in size so that, if necessary, it could be over-stressed with the power available. With a 50,000-kVA source of power the switch models were regarded as being one sixty-fourth of their commercial cubicle content with the object of obtaining a switch with a commercial maximum rupturing capacity of about 50,000 and comparing its performance with a full-scale switch of 1,500,000-kVA capacity. Such a full-sized switch would be about the largest commercially available, and thus one which would be likely to be used on a short-circuit power of 1,500,000 kVA. With a larger source of testing power a correspondingly larger switch was employed. The largest used, excluding the quenched arc switches, could break a maximum power of 200,000 kVA. In no group of tests were fewer than five repeated tests carried out under similar conditions, but when there were reasons to believe that closer investigation was necessary as many as twenty-five repeated tests were made. The work described in the paper was carried out at intervals over a period of eight years.

Arc stability is shown to produce greater consistency of distress symptoms than is possible with an oil switch of ordinary form, and the new step is to reduce the amount of energy appearing at the arc under given circuit conditions. This reduction can take two forms: one of magnitude by reduction of voltage which appears across the arc, and the other of time by reduction of the arcing period. The first can be achieved with an arc of low resistance per unit of cross sectional area, and the second by rapid abstraction of the heat of the arc and consequent reduction of ion generation upon which the liability of the arc to continue depends. The control of ion production, the author explains, is really at the root of the matter, but the majority of the existing circuit breakers bear little evidence of this principle having been recognised. The quenched arc switch shown in Figs. 1 and 2 is designed to embody the above principles. The energy dissipated at the contacts is reduced to a low value and abstracted in the form of low-grade heat, thus preventing it being passed to the surrounding air, gas or oil, in any other form than that of low-grade heat. The switch is arranged with a central orifice with lateral discoid openings between heavy metal plates between which a powerful quenching action is set up. This portion of the switch can be under oil, thus preventing the formation of gaseous conducting paths, but a large head of oil is unnecessary, a large air cushion being frequently beneficial. The arc is opened by withdrawing a central contact rod from a circuit contact under the oil; the rod then passes the discs—or other surfaces—successively, the arc being forced by magnetic and thermal action into the radial extinguishing openings. The extinguishing process takes place at a comparatively small radial distance from the central rod when medium amounts of power are being handled, while with greater amounts of power the path of travel becomes longer and broader, finally emerging into an annular extinguishing chamber near the outer edge of the discs where the heaviest power can be quietly broken. Arc stability is produced mainly by the metal discs which constitute guiding contacts, and partly also by the concentric iron container. When passing through the radial openings the arc is formed into a series of annular sections which are kept constantly in motion, expanding radially under conditions of gas pressure and temperature which produce a low arc voltage and assist in the rapid extinction process. These are the factors which determine the fundamental voltage basis for a given design of switch. The correct pressure and temperatures are automatically provided under all conditions of breaking, and the moving parts are simple and strong. There are no valves, pipes or delicate parts, and the construction can be more robust both mechanically and electrically than the oil switch of conventional form. The current-carrying and arcing conductors are heavy and the insulation clearances considerable. Although strong construction is an inherent feature of the design, this ranks only as an additional safeguard, as, in practice, the pressure set up during the breaking process is negligible.

Arrangements of baffles, metal and other cooling discs

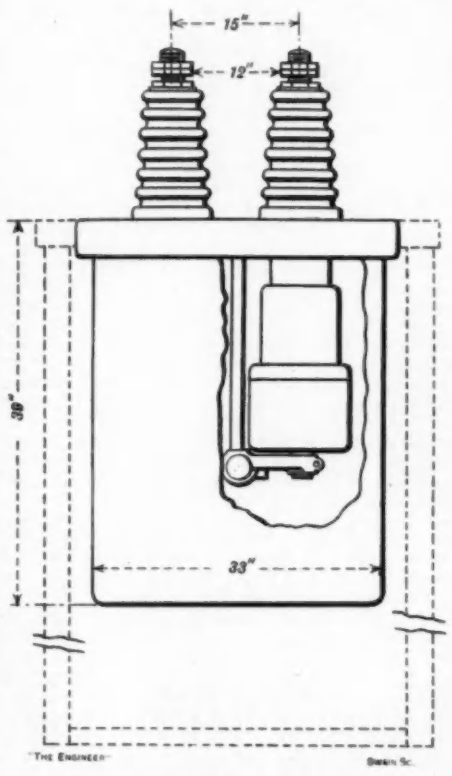


FIG. 2—TWO MILLION kVA SWITCH

and similar arrangements have been previously proposed on various occasions, but these arrangements, the author contends, have been generally more or less haphazard and do not appear to have followed a logical scheme. Such of them as have been tested, the author states, have not shown any radical improvement in performance distinguishable from existing forms of switchgear, and sometimes they are actually dangerous.

Oil is introduced with the object of reducing insulation clearances. This is important, since a switch operating in a gaseous medium must necessarily have considerable clearances to prevent the arc and arc gases forming a conducting path; the oil enables the clearances between live parts and earth to be cut down to about 25 per cent. of those necessary in an air design. During operation, the oil is forced automatically from the arcing area, but not from the region where it is required to maintain the insulation. When the arc is extinguished the oil passes back into and scavenges the cells.

A switch measuring 6in. in diameter by 6in. long and weighing less than 28 lb., interrupted on numerous occasions 50,000 kVA at 6000 volts without any external sign of its operation. There were none of the symptoms usually obtained with an oil switch, such as noise and gas, oil or flame, and, most important of all, no measurable pressure was set up in the container. Another switch unit, 6in. in diameter and 3in. long, interrupted the same amount of power, again without any distress. Attempts to measure the duty on the container by the deformation method used for the other tests described in this paper gave no indication of pressure.

Examination of the oscillograph record rarely showed any perceptible voltage during the arcing period, the arc being extinguished very rapidly and without any signs of instability. As no appreciable voltage is set up across the switch there can be no material amount of power expended in it, and consequently no generation of pressure inside it. Actually, of course, there must be some voltage, but it is a small percentage of that which would be set up across the contacts of an ordinary oil switch under similar circuit conditions. Prolonged arcing is said to be effectively and safely prevented and secondary effects on the oil are found by observation to be reduced to a negligibly low value. In one of several series of tests a group of twelve short circuits of 5500 volts was applied at intervals of thirty seconds, and whilst the switch was not opened out and received no attention whatever between the tests, the same oil being used throughout, it operated perfectly in all these tests. No arc voltage was indicated and no deformation of the pressure indicating apparatus was recorded. A few tests under different conditions are given in the following table:—

Voltage.	kVA.	Size of unit.	Performance.
Volts.		in. in.	
6,000	50,000	6×6	Not near limit
6,000	50,000	6×3	No sign of distress
5,500	8,250	6×4	No sign of distress
3,100	2,800	6×4	No sign of distress
4,520	7,200	6×4	No sign of distress
5,240	10,600	6×4	No sign of distress
11,000	230,000	6×4 (3 units, 2 per phase)	Operated quietly. No distress

Fig. 1 shows the commercial form of an ironclad oil-immersed circuit breaker of the quenched arc type with a breaking capacity of about one million kVA—true, not commercial rating. Fig. 2 shows an enclosed two million kVA, 33-kV breaker. The highest power so far broken by this switching device in any test is 230,000 kVA, and, in all, approximately 100 full-scale short-circuit tests have been carried out. By "full scale" is meant short circuits involving 50,000 kVA and over.

The present limitation of the oil switch is mechanical, and it is this factor which is responsible for the economic difficulty in the way of further developments. The new device has apparently no such limitations. When breaking a 50,000-kVA short circuit it has been proved that a unit measuring about 6in. by 6in. can meet all demands with perfect ease. To do this with an oil switch embodying the various important features discussed in this paper, *i.e.*, massive mechanical construction, multi-break, correct speed of break, correct air cushion, &c., would necessitate a unit much greater in size than the new switch. There would, moreover, be this important difference: when the ordinary oil switch is breaking under short-circuit conditions considerable mechanical stress would result, whereas the quenched arc switch of smaller size would break the same power with no appreciable mechanical stress.

It would appear that there is no great difficulty in designing a circuit breaker of the quenched arc type to deal with two or three million kVA on the 100 per cent. service basis.

THE BEAUHARNOIS POWER CANAL.

WORK on the Beauharnois Power Canal on the St. Lawrence River, which began on August 1st, was carried on steadily until the end of December. The work already completed includes the excavation of some 500,000 cubic yards, the erection of 15,000ft. of dyke, which will line the side of the canal, the excavation of 80,000 cubic yards for the feeder canal, and the grading of 3 miles on the construction railway on which the track has been laid for 1¼ miles. During the first three months of this year, much of the outdoor work will cease, operations being confined mainly to blasting and taking out the rock at the power-house site. Other works to be carried out during the winter months include the assembling of the dredger, which is to excavate at the rate of 1100 cubic yards an hour; the assembling of four movable steel tower excavators with buckets which will scoop out 10 cubic yards; and the erection at the power site of an electric shovel, which will lift 8 cubic yards up to 56ft. in each dipperful. Other drag-line shovels will also be assembled and erected. Construction plans for 1930 call for the employment of 1000 men. At the upper end of the canal near Valleyfield, the new dredger will excavate some 3,000,000 cubic yards. The four movable steel tower excavators will take out about 3,500,000 cubic yards in the centre section of the canal. The six petrol-engined shovels will continue to do the work of dyking the route. At the lower end of the canal some 450,000 cubic yards of rock will be taken out by the electric shovel. The undertaking is more of an embanking than an excavating operation, as, virtually, the entire route of the canal lies below Lake St. Francis, from which the canal will divert water around the whole of the Beauharnois section of the St. Lawrence. To handle the work next spring, the construction railway will operate ten locomotives, ten flat cars, and sixty dump cars. This rolling stock will be standard railway equipment, and will operate on the 27 miles of standard gauge line which will be completed in the early summer. Ultimately, the Beauharnois railway will run parallel on both sides of the canal, and will have a total trackage of more than 40 miles. Sidings connecting with the Canadian National and the New York Central Railways have already been completed.

IT is proposed to mine bauxite in Dutch Guiana by the Surinammsche Bauxite Maatschappij of Paramaribo to the extent of 150,000 tons a year.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DEFERRED PAYMENTS.

SIR,—On all economic questions there must of necessity be strongly marked differences of opinion.

The factors in every economic problem are so many and so complex that no one, probably, ever appreciates more than a comparatively small proportion of them, and as different investigators usually get hold of different sets of factors conflicting conclusions are very natural.

There are some parts of Mr. Gaudin's letter which are difficult to understand. For instance, I am completely fogged by the sentence: "The consumer in return must receive money in excess of what he receives either in wages, dividends, or salaries."

It is difficult, also, to understand his objection to the Export Credits Scheme, which offers a very welcome measure of partial insurance against bad debts abroad. It has undoubtedly been the means of providing a good deal of useful work, and, as the exporter always takes a considerable proportion of risk himself, anything in the nature of reckless trading is discouraged.

The present Government is undoubtedly genuinely anxious to increase employment and to improve the condition of industry, but it is apparently more inclined to concentrate on palliatives, than to face the root cause of our trouble, which is, in fact, the difficulty of finding markets for our manufactured goods abroad and the extent to which our home market is at the mercy of foreign competition.

While many branches of engineering are, and have been for some time past, surprisingly good, we cannot hope for any general return of prosperity until such important and basic industries as agriculture, coal, cotton and the heavy iron and steel trades are able to flourish.

Our home market, important as it is, can never take the place of our export trade, which alone can pay for the foodstuffs and raw materials, which we must import.

Temporary palliatives, credits, loans, and the like, are of undoubted benefit in moderation, provided the industries to which these facilities are granted are soundly constituted and capable of working at a profit under the conditions of the day. The mere provision of credit in the case of an industry, which is condemned by circumstances to work unprofitably, only prolongs the agony without curing the disease.

Similarly, the initiation of exotic schemes of work solely to provide employment, while serving a temporary purpose, can never in the long run take the place of the natural expansion and development of normal trade. All special purpose expenditure falls ultimately on those branches of industry which are productive, and actually imposes a further handicap of taxation on those trades. Moreover, very few of these special schemes are likely to give an adequate return, if any, on their cost.

The most valuable help that any government can give to industry is to devote itself to bringing about those conditions in which industry can flourish, and to abstain from detailed interference in trade itself. British manufacturers are quick to take advantage of every opportunity and show great initiative in increasing and improving their plants wherever there is a reasonable prospect of selling their products to advantage.

It has been truly said that trade follows the flag, and the importance of showing our flag throughout the Seven Seas cannot be overrated. For this reason, and indeed for many others, the larger majority of industrialists look with grave apprehension on any proposals further to reduce our Navy.

Our foreign markets are becoming continually more difficult of access through the constantly increasing tariff walls with which they are surrounded. Whenever an increase in tariffs abroad is suggested, we usually make "representations," but I can remember no instances in which these representations have been successful, for the obvious reason that our present policy gives us no bargaining power.

There are rumours of a conference to consider a tariff truce, but this, if successful, could only result in the perpetuation of the very situation which is responsible for most of our industrial troubles.

When it comes to a war, we do usually in the long run win, though, admittedly, only by a short head; but our experience of conferences and conversations since the last war can only confirm the impression that we almost invariably come out second best from these discussions. All nations are selfish, and we can hope to obtain concessions, not by smooth words alone, but only by the ability to offer something valuable in exchange. There are signs at last of a stirring among the dry bones and of a realisation that the policies and traditions of the past are unsuited to the changed conditions of to-day.

Coming now to the actual question of deferred payments. It is generally admitted that deferred payments, usually represented by some form of hire purchase, are legitimate and proper in connection with the buying of productive assets, which are necessary additions to capital account such as plant for the equipment or modernisation of industry. Here tangible assets are created, which form a sufficient security for the outstanding balances of deferred payment, and which frequently pay for themselves very quickly by the increased earning capacity which they provide. My own company has during many years supplied a large quantity of machinery on this system, and is always prepared to do so.

Deferred payment also obtains very extensively in the purchase of motor cars, where experience shows that on the whole it works well, but it has not reached in this country (and let us hope it never will) the same pitch as in America, where it appears to be applied almost universally. Nor can it be considered sound business policy to apply any system of deferred payments to the purchase of raw materials, or other disappearing items of current consumption.

It is difficult to avoid the conclusion that any widespread system of deferred payments may easily reach a condition similar to that produced by inflation in its worst form, leading to the discouragement of thrift, self-denial and all the sounder and sturdier qualities of the community, and that its ultimate financing, although ostensibly from the State, again constitutes a load on normal self-supporting trade. If carried to excess it would seem likely to bring about an ultimate collapse which might well be disastrous.

Brandy and soda, and even cocktails, may act as useful stimulants, but they cannot take the place of solid food.

Coventry, January 27th. ALFRED HERBERT.

SIR,—We have read with interest the letter by Mr. R. Gaudin in your last issue, but if all the trade of this country were carried out on the lines of Mr. Gaudin's suggestion, how would he propose that this country should pay the vast amount required for its food bill from abroad, amounting to over £500,000,000 per annum?

From Mr. Gaudin's letter he appears to think that foreign trade is of no use to us, and we should only encourage trade among ourselves on the principle, we suppose, that we should all exist by taking in each other's washing. It is only by its export trade that this country can exist, and we welcome any suggestions from the Government to increase this export trade to the utmost possible extent.

Widnes, January 29th. R. WHITE AND SONS.

NAVAL HISTORY.

SIR,—Your reference to the death of Professor Hugh Longbourne Callendar prompts me to crave a little space for reference to the work of another professor of a somewhat similar name, viz., Professor Geoffrey Callender, M.A., F.S.A., who is also a gentleman of great ability hampered by modesty. His work is not nearly so well known as it should be. He is Professor of History at the Royal Naval College, Greenwich, and has given the country a number of volumes which should be very carefully studied by all who wish to appreciate the position of Great Britain as a Naval Power and the magnificent part played by the British Navy in history.

There is a very unfortunate impression abroad, a very wrong impression, which has its seeds in the famous works of Admiral Mahan, viz., that if you want a country to prosper you must build a tremendous Navy and beat the "big drum," after the manner of the would-be "Admiral of the Atlantic." The British Navy has not been founded on such ideas. Its foundations are in defence and beneficence, rather than in militarism and arrogance.

The virility of the British nation, which expressed itself in industrial, mechanical, scientific, and maritime developments of every kind, also found its expression in the provision of a Navy, ubiquitous and powerful, not for the purpose of dominating other nations, but for the purpose of promoting the ordered progress of civilisation in every land, for the exploration of the ocean to the common advantage of all mankind, for the repression of piracy, for the restraint of "Admirals of the Atlantic," and for the assistance of distressed and beleaguered people of any tribe or nation.

At this time there is much misunderstanding and misrepresentation of the actual *rôle* of the British Navy, which is partly wilful, but is largely due to ignorance and narrow views. It is, therefore, very necessary that all people who have the welfare of this country at heart should take a broader and more intelligent view of the position of the British Navy in relation to world progress. For this purpose I would very respectfully recommend the earnest study of the works of Professor Geoffrey Callender, and, in particular, the study of his volume entitled "The Naval Side of British History." It will perhaps then be realised more clearly that a powerful British Navy, "Ready, aye, ready!" is the best guarantee for the maintenance of civilisation which is at present available.

J. H. NARBETH.

St. Leonard's-on-Sea, January 29th.

REGISTRATION OF TESTS.

SIR,—I have recently read with very great interest Mr. R. H. Parsons' paper presented to the Institution of Mechanical Engineers on "The Registration of Reliable Tests of Power Plant Machinery."

I have felt for some time past that there is a real need for some competent body of engineers who could act as a registration authority for plant tests and thus, as it were, give the "hallmark" to properly conducted trials under a specified code.

After several years of painstaking work, the Committee on Heat Engine Trials, set up by the Institution of Civil Engineers in conjunction with other institutions, have evolved a standard code for the conduct of trials, and there seems to be no valid reason why their recommendations should not be generally adopted. At present, however, there is a certain amount of apathy in regard to the matter, with the result that tests on plant are carried out in various ways depending on the idiosyncrasies of the parties concerned and, in some cases, with detriment to the manufacturers.

It has been my privilege to carry out a considerable number of tests on power plant during the past nine years, and speaking from experience of the various conditions imposed, both in specifications and tests on site, I am quite convinced of the necessity of the adoption of a standard code and the setting up of an impartial committee on the lines suggested in the paper.

Competition amongst manufacturers of plant tends to become keener every year, and it is an unfortunate fact that in order to face foreign competition, British manufacturers are compelled to cut their guarantees to, in some cases, an almost impossible limit. The setting up of an impartial committee for the registration of tests and the consequent adoption of a standard code would, I feel certain, be of great value, not only to manufacturers themselves, but to both purchasers and consultants, who are of necessity very greatly interested.

It is to be sincerely hoped that, as a result of the suggestions in the paper, we shall soon have an authoritative committee set up for the registration of power plant tests in this country.

L. M. JOCKEL, M.I. Mech. E.

Nottingham, January 25th.

LINKS IN THE HISTORY OF THE LOCOMOTIVE.

SIR,—Mr. Forward seems to have fallen into a curious error in regard to Blenkinsop's charges for royalty.

He quotes Blenkinsop: "The patent right at £10 per cwt. is £800 per annum," and then assumes that "the proposed royalty of £800 per engine would swallow up half the estimated savings." It is obvious that "£10 per cwt." is a misreading for "£10 per cent." £800 per annum then becomes intelligible as 10 per cent. of the estimated saving of £7995 on five engines, and this explains Blenkinsop's reference to Boulton and Watt's royalty of 33⅓ per cent. on savings by way of contrast to his own moderation. Coupling Blenkinsop's letter with Matthew Murray's of April 17th, 1813, it appears that the conditions on which business was to be done were these: The colliery was to purchase the engines from Fenton Murray and Wood at £350 apiece, and was to pay a royalty to Blenkinsop of £800 per annum, being 10 per cent. on the estimated annual saving on five engines. Out of this Blenkinsop would pay ⅛th, or £100, per annum to John Watson "for superintendence of the business." One imagines that in the great days of industrial expansion, enterprise was frequently stimulated by making it worth the while of responsible officials to move, a system which was not without its advantages, and is still practised in less enlightened countries. Later, Blenkinsop drops his royalty with a bump to £50 per engine, but it does not appear what happens to Watson's commission.

F. L. WATSON, M. Inst. C.E., M.I. Mech. E.

Leeds, January 29th.

THE INSTITUTE OF METALS.

THE twenty-second annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1, on Wednesday and Thursday, March 12th and 13th.

The following programme has been arranged:—On Wednesday, March 12th, at 10 a.m., there will be a general meeting in the Hall of the Institution, when the report of the Council and report of the honorary treasurer will be presented, and the results of the elections of the Council for 1930–31 and of new members will be declared. The President, Dr. R. Seligman, will then read his address, after which papers will be presented and discussed. Further papers will be discussed in the afternoon, and at 7 p.m. the annual dinner, which will be followed by a dance, will be held at the Hotel Victoria (Edward VII. Rooms) Northumberland-avenue, S.W. 1. The whole of the Thursday will be devoted to the consideration and discussion of papers.

The following papers are expected to be submitted:—N. P. Allen, "Experiments on the Influence of Gases on the Soundness of Copper Ingots"; E. J. Daniels, "Unsoundness in Bronze Castings"; W. E. Prytherch, "Gases in Copper and their Removal"; L. Davies and L. Wright, "Protective Value of Some Electro-deposited Coatings"; Dr. C. F. Elam, "The Diffusion of Zinc in Copper Crystals"; R. Genders, "Macrostructure of Cast Alloys: Effect of Turbulence Due to Gases"; R. Genders, "The Aluminium-brasses"; Professor B. P. Haigh, D.Sc., and B. Jones, "Atmospheric Action in relation to Fatigue in Lead"; Dr. D. Hanson, S. L. Archbutt, and Grace W. Ford, "Investigation of the Effects of Impurities in Copper: Part VI., The Effect of Phosphorus in Copper"; W. R. D. Jones, "A Note on Metallic Magnesium"; R. Lancaster and J. G. Berry, "A Note on Zinc-base Die-casting Alloys"; Dr. T. A. Rickard, "The Early Use of the Metals"; Dr. D. Stockdale, "The Composition of Eutectics."

MAY LECTURE.

The annual May Lecture will be given on Wednesday, May 7th, by Major F. A. Freeth, D.Sc., Ph.D., F.R.S., joint research manager, Imperial Chemical Industries, Ltd. Further particulars will be supplied in due course.

AFTER being head of the Shanghai Municipal Electrical Department for over 28 years, Mr. T. H. U. Aldridge has relinquished his office as vice-president and general manager of the Shanghai Power Company—the new name of the undertaking since August last—and is coming to London to join the American and Foreign Power Company. During the time Mr. Aldridge was in Shanghai the capacity of the plant increased from 550 kW to 161,000 kW, and an extension of 50,000 kW is now being considered. He is succeeded by Mr. C. S. Taylor, the deputy general manager of the company.

Railway and Road Matters.

SEVERAL references have, from time to time, been made in this column to the aerial ropeway between Tilmanstone Colliery and Dover Harbour. It may now be noted that it was opened throughout on January 24th.

IT is announced by the railway companies that Mr. A. Newlands, chief engineer of the L.M.S. Company, has been elected chairman of the Railway Clearing House Civil Engineers' Committee for the year 1930.

THE circumstances that led to the collision of January 8th between the night express from Shrewsbury and a standing freight train at Stapleton-road, Bristol, were inquired into by Lieut.-Colonel Mount on the 14th. At the request of the men's unions the inquiry was not open to the public.

THAT popular "Stratfordian," Mr. C. W. L. Glaze, the mechanical engineer, Stratford, London and North-Eastern Railway, retires at the end of March after forty-five years' service. Mr. Glaze will be succeeded by Mr. Edward Thompson, who has been assistant mechanical engineer, Stratford, since June, 1927, prior to which he was carriage and wagon workshops manager, North-Eastern area.

AUTOMATIC road traffic signals, similar to those to be found now in most towns, are at last to be tried in London. In a written reply to a question the Minister of Transport stated that he had approved of a proposal to install them in Oxford-street. We would add that these signals differ from those fixed in Piccadilly in that the latter are not automatic, but are worked by a constable in a shelter at the top of St. James-street.

THE London County Council, at the suggestion of the Underground Railways, proposes that escalators be provided between the contemplated new terminus of the Southern Railway at Waterloo and the stations of the Underground there; also that the site of the existing Metropolitan District stations at Charing Cross be added to Embankment Gardens and a new station provided on the new Charing Cross Bridge at bridge level.

THE report for the year ended March 31st, 1929, of the South African Railways showed that, compared with 1927–28, the revenue increased by £785,891, or 3·11 per cent., and the expenditure by £98,656, or 0·53 per cent. The number of passengers carried—practically 82 millions—established a record. Of the 542,357 trains run, 85 per cent. arrived at their destinations "on time." A record was also established in the over 12 million tons of merchandise and the 14¼ million pounds receipts therefrom. Those figures are independent of the over 9¼ million tons of coal and nearly 4 million pounds revenue.

ON the re-assembling of Parliament on January 21st, Mr. J. H. Thomas stated, in answer to a question, that a grant had been made for converting the L.M.S. line between Dagenham and Upminster for electric traction, and that the company had undertaken to do the line between the present terminus of electrical working at Barking and Dagenham. A grant has also been made for the conversion of the Wirral Railway. Answering a further question Mr. Thomas said that the question of Liverpool-street could not be dissociated from the whole question of London traffic and that negotiations on these lines were taking place.

SPEAKING at the Mansfield Chamber of Commerce on January 23rd, Sir Josiah Stamp referred to the Coal Mines Bill, and, to quote from a leader in the *Manchester Guardian*, stated the case for the railways "with a moderation which is in refreshing contrast with the rhetorical manifestos of some other sections of consumers." He said that if the railways had to pay 2s. 6d. more per ton for coal the increased cost would be £2,500,000 a year. There were only three ways by which that could be met—by reduced dividends, higher railway rates and a reduction in the men's wages. Sir Josiah hoped, however, that the Government would not be deterred from renewed efforts to find truly economic remedies for the troubles of the coal industry.

THE directors of the Great Western Railway have approved the expenditure of £200,000 on the following works in connection with the Government's schemes to relieve unemployment:—St. Austell: New goods station necessitated by increasing traffic and to expedite the transit of freights. Hockley: Extension of warehouse accommodation to meet increasing demand of freighters and to provide for future development. Swansea: New warehouse to meet growing demand of freighters and to provide for future developments. Small Heath: New four-floor warehouse necessitated by the growing demand for storage accommodation and to provide for future developments. Paddington–Southall: Substitution by light signals of the semaphore arm and oil lamp signal on the running lines. These works are in addition to the £5,000,000 schemes previously authorised, all of which have now been commenced with the exception of the enlargement of Cardiff General Station, the rebuilding of Bristol Temple Meads passenger station, and the deviation of the main line between Westbury and Frome.

PLANS for a new locomotive, which, it is claimed, will be the largest in the British Empire, and which is to be constructed by the Canadian Pacific Railway in its Angus shops in Montreal, have been got out by H. B. Bowen, chief of motive power and rolling stock. The new locomotive is to have a tractive effort of 83,200 lb., which is 5200 lb. more than the "5900" series, and 37,900 lb. greater than the "2800" series, the fastest and most modern passenger engines now in operation. It will have a two-wheeled leading truck, five pairs of driving wheels, and a four-wheeled trailing truck, and will be known as the Canadian Pacific Railway "T-4–A" class. The engine alone will weigh approximately 466,500 lb., and the tender 297,500 lb., a total weight of 764,000 lb., or, say, 341 tons. It will operate under multiple pressure, and will burn oil fuel. High pressure will be used in the centre cylinder at 850 lb. This steam will be generated by heat interchange coils, in the high-pressure drum, the coils being part of a sealed system consisting of tubes which will contain distilled water. Pressure of about 1350 lb. will be carried in the closed generating system and the heat interchange coils. Canadian material will, as far as possible, be used in the construction of the locomotive.

Notes and Memoranda.

POTATOES are now being canned in Florida in the same way as other vegetables and fruits, and a factory in the heart of the Southern United States potato-growing area is producing 5000 cans daily.

IT is claimed that the business of A. Shaw and Son in the manufacture of industrial diamond tools is the largest of its kind in the world. It has just been moved from Clerkenwell to Waterloo-road, Cricklewood.

THERE is in the Haitian jungle, according to *Power*, an old beam engine bearing the inscription, "Joseph Lindsay, Haigh Ironworks, near Liverpool, 1818," which, although it is derelict, has suffered very little from corrosion or rusting.

IN a brief note on hydro-electric projects *Indian Engineering* says:—"Confining our attention to South India, we find that at present Rs. 9,505,000 is sent out of the Madras Presidency annually to pay for coal and oil, while, if hydro-electric resources are sufficiently developed in the Presidency, a sum of only Rs. 4,900,000 will go out."

IN Research Paper No. 117, issued by the American Bureau of Standards, is a detailed description of a machine which has been developed by S. Epstein and J. P. Buckley for the automatic polishing of metallographic specimens. It should be of interest to all metallurgists and is issued by the Superintendents of Documents, Washington, price 10 cents.

IN calculating the expansion of steam pipes it was sufficient at one time to assume that the coefficient of expansion of steel was constant for all temperatures, but recent research has shown that the expansion coefficient increases with the temperature. For instance, the coefficient of expansion of steel at 800 deg. Fah. is approximately 20 per cent. greater than at 200 deg. Fah.

THE total number of motor vehicles, excluding tramcars and trade licences, in Great Britain on November 30th, 1929, was approximately 1,863,000, compared with 1,758,000 in the corresponding period of the previous year. The total number of mechanically propelled road vehicles registered for the first time in November, 1929, was 19,058, compared with 18,843 in November, 1928.

EXPERIMENTS in wheat breeding at the Government experimental farm at Ottawa are being carried out rapidly by the use of electric light in greenhouses. The secret of the rapid ripening of wheat in mid-Western and North-Western Canada is the length of daylight during the brief summer. Scientists evolving new varieties of wheat specially adapted to the climate of Western Canada used to take eight years to complete all the stages of hybridisation necessary to prove the value of an experiment, as they always had to wait for the summer before taking the next step in their experiments. Now, working under glass in the winter and using a battery of 300-watt electric lamps to provide artificial sunlight in the short dull days, they are, it is said, successfully producing two seed crops a year.

ACCORDING to an article in *Archiv für das Eisenhüttenwesen*, by Heinrich Hanemann, of Berlin, and Artur Schildkötter, of Rheinhausen, they have determined the limits of the "mixing gap" in the liquid state sulphur-iron-carbon system and the course of solidification in the ternary partial system iron—iron carbide—iron sulphide. The dissociation in the liquid state of iron-carbon alloys when large quantities of sulphur were present, which had been noted by previous investigators, was confirmed, and the limits of the mixing gap in the liquid iron—iron carbide—iron sulphide-ternary system were determined. The ternary eutectic of the system was found with a concentration of about 10·5 per cent. Fe, 2·5 per cent. Fe_3C, 87 per cent. FeS and at a temperature of 978 deg. Cent. The condition diagram of the system was plotted on the basis of thermal and metallographical researches, and a survey given of the solidification processes in the different condition zones.

AN alternative source of helium to the natural gas used in America, which is of great interest in the possible applications of the gas in the British Empire, is the mineral monazite, the raw material for the production of thoria for incandescent gas mantles, which is found in large quantities in Travancore, India. In the issue of December 27th of the *Journal* of the Society of Chemical Industry, Mr. R. Taylor, who has been working in the Chemical Research Laboratory at Teddington under the direction of Sir Richard Threlfall and his successor, Professor G. T. Morgan, describes some interesting experiments on the production of helium from monazite. The mineral contains about 1 c.c. of helium per gramme, and thus in the working up of every 100 tons of monazite about 100,000 litres of helium are allowed to escape into the atmosphere. The gas escapes on heating, and the paper describes how it is purified by treatment with hot metallic calcium, which absorbs nitrogen and other gases. It is advantageous to remove most of the nitrogen by heated magnesium before treatment with calcium. Working drawings of the apparatus are given in the paper.

ACCORDING to a contribution by C. H. Fellows in the *Journal* of the American Waterworks Association, in high-pressure boilers the corrosive action of pure water is of primary importance. Small-scale experiments having indicated that superheated steam contains more free hydrogen than does saturated steam, a stream of water vapour was passed under varying conditions of temperature and pressure through tubes of either low-carbon steel (0·10 per cent. C) or chrome steel (16·35 per cent. Cr) and the amount of hydrogen determined before and after. It was found (1) that a low-carbon steel was more liable to cause dissociation than chrome steel; (2) that the rate of decomposition increased with rise of temperature and decreased as the thickness of oxide film formed increased; whilst (3) within the limits used, variation in steam pressure was without effect. The velocity of the steam through the tube was considerably lower in the experiment than in actual practice, and since later investigations indicate that at still higher velocities no hydrogen whatever can be detected, it would seem that there is a definite relation between steam velocities—which are an important factor in determining the temperature of the metal—and oxidation of the latter due to the dissociation of steam.

Miscellanea.

THE Delaware River is to be dredged to a depth of 20ft. between Philadelphia and Trenton.

A RECORD is claimed for the Maltby Main Colliery, South Yorkshire, in raising 18,087 tons in one week.

THE last of the blast-furnaces at the Tees Bridge Ironworks, Stockton-on-Tees, has just been demolished.

IT is proposed to erect a large oxygen-making plant in Pressburg, Czecho-Slovakia, at a cost of 5 million crowns.

THE new East-street cantilever bridge in Pittsburgh, U.S.A., has just been completed. It crosses a ravine in the town at a height of 220ft., and has a span of about 700ft.

WORK has been started on the exploitation of the mercury ore deposits of the Bugojno district of Yugo-Slavia, with two furnaces each having a capacity of 8 tons a day.

AN aerial passenger service is being organised from Edmonton, Alberta, to the Arctic Circle. It will be run by machines capable of carrying from twelve to fifteen passengers.

A WIRELESS station which is claimed to be the most powerful in Europe was opened on January 17th at San Palomba, near Rome. The transmitting power is 50 kilowatts and the wave length 441 m.

THE Barnsley seam of coal has been struck in the sinking operations of the Upton Colliery, South Yorkshire. It is 9½ft. thick, and of its usual good qualities. It is expected to employ about a thousand men by April.

THE docks of the Canadian National Steamships, along the Pacific Coast, are to be remodelled and extended to accommodate the new coastwise steamers, which are being put into service. The three new steamers are being built at Birkenhead at a cost of over £1,000,000.

A FACTORY for the manufacture of sodium sulphide, with a capacity of 10,000 tons a year, has been put up at Machatsh-Kala, in Daghestan, Russia. The raw material, sodium sulphate, is to be drawn from Kara-Bugas Bay, and much of the product will be exported.

THE new Heenan and Froude combined salvage and incinerator plant, which is being installed at Rotten Park by the Birmingham Corporation, has two five-cell units with mechanical grates, and will be capable of dealing with 250 tons of refuse a day. There are to be three independent screening units.

THE electrification of the pits of the Cowpen Coal Company is being developed rapidly. The ventilating plant at the Cowpen Colliery, Blyth, has now been changed over to electric drive, and the steam plant at South Newsham is about to be closed down. Electric winding machinery has already been adopted at the Crofton and Isabella pits.

AN official Federated Malay States Report states that in 1928, 1898 oil engines, with an aggregate horse-power of 109,926, and 348 gas engines, with an aggregate horse-power of 19,188, were registered. These figures show an increase over 1927 of 180 oil engines and 25,048 horse-power and a decrease of 2 gas engines with 128 horse-power.

H.M. SENIOR TRADE COMMISSIONER in South Africa has forwarded copies of the Electricity Supply Regulations for the City of Capetown and the Municipality of Port Elizabeth. Copies of the Regulations are available for loan to British firms, in order of application, to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

AN electrically-driven arc-wall coal-cutter is being installed in West Sleekburn Colliery, Bedlington, owned by the Bedlington Coal Company, Ltd., It is the first of its kind to be used at the colliery, and has a jib 7ft. 6in. in length. Production by hand has, says the *Iron and Coal Trades Review*, been very slow for a long time, as the coal is hard, and it is for that reason that the coal-cutter is being installed.

ONE of the largest food canning factories in Europe is, says *Tin*, being erected at Astrakhan in Russia. The new cannery, which is situated at the mouth of the Volga river, will have an initial capacity of over 28 million cans of food annually, including 20 million cans of tomatoes and vegetables, 4 million cans of fish, and 4·5 million cans of meat. The factory is to be completed in time to deal with the 1930 pack.

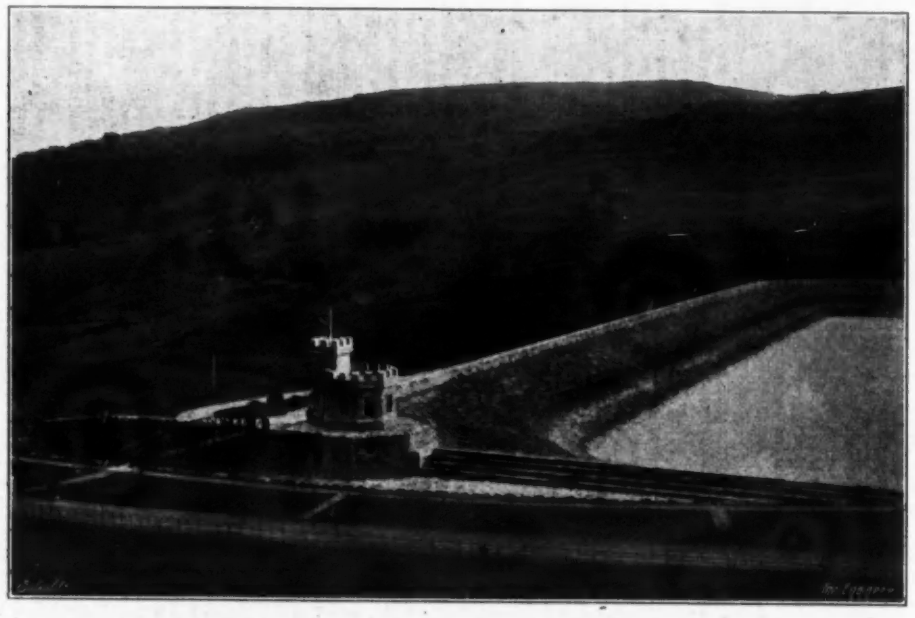
IT is proposed to build another bridge across the St. Lawrence at a cost of about a million pounds. The river would be crossed in three spans, the first extending from a point about 4 miles East of Cornwall, on the Montreal–Toronto highway, to Colquhoun Island. The central span between Colquhoun Island and St. Regis Island would be raised to give a clearance of 150ft. across the main channel of the St. Lawrence and not interfere with the deep waterways and power development proposals. The third span would carry the highway from St. Regis Island to the village of St. Regis on the South shore. The water channels at this point total about 1¼ miles in width, and the entire length of roadway would be over 2 miles.

IT is hoped to open the Bavarian Zugspitze Mountain Railway, the upper station of which will be 9750ft. above sea level, by March. The first section of the line, 4·7 miles in length, will be run by ordinary adhesion locomotives, the maximum gradient being only 3·5 per cent. The next section, 6·9 miles long, will be a rack railway, and the final aerial ropeway to the summit will be 0·37 mile long. The maximum gradient on the rack railway is 25 per cent., and on the aerial ropeway 68 per cent. When the final section leading to the summit is completed next summer, the total time taken by the trains from the low-level station at Garmisch-Partenkirchen—altitude 2300ft.—to the summit will be 1 hour 50 minutes, 3 minutes only being required for the aerial ropeway. The electric energy required for the railway is supplied by three-phase current from the Isar power station. At the sub-station it is converted into direct current at 1500 volts by glass-bulb rectifiers, which, at full load, will work at 1650 volts. These rectifiers are novel in design and are being used in practice for the first time.

SHEFFIELD WATER SUPPLY—NEW WORKS IN THE EWDEN VALLEY

THE LATE MR. COLIN CLEGG M. Inst. C.E. SHEFFIELD, ENGINEER

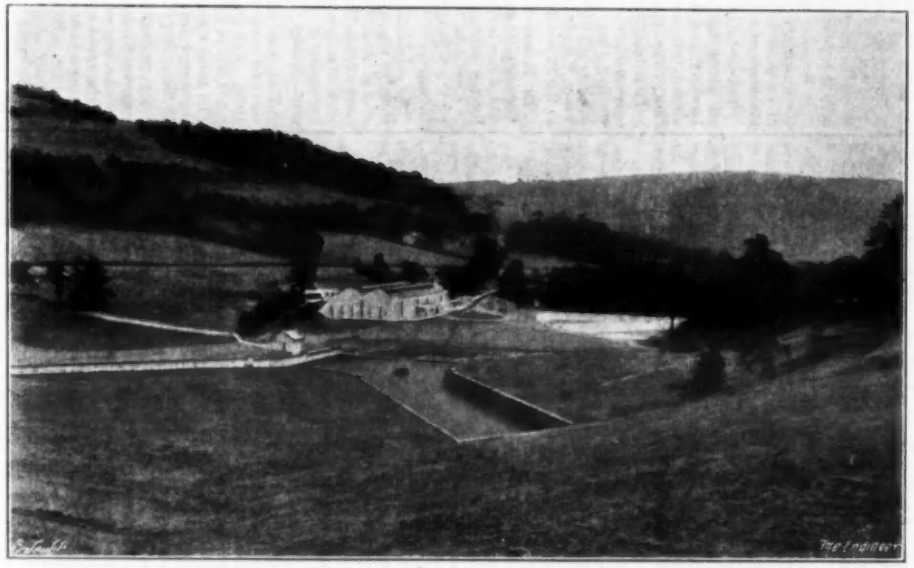
(*For description see page* 124).



BROOMHEAD RESERVOIR, VALVE TOWER AND HEAD OF BYE-WASH

MORE HALL RESERVOIR EMBANKMENT AND DISCHARGE TUNNEL

BROOMHEAD BYE-WASH—MORE HALL RESERVOIR IN BACKGROUND



GENERAL VIEW OF FILTER HOUSE FROM MORE HALL RESERVOIR

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The Metallurgist.

THE JANUARY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

JANUARY 31, 1930.

Agricultural Engineering.

No industry has undergone such great changes during the past decade as agricultural engineering. Nor is there any sphere of mechanical activity that has spread so widely since all countries of the world saw the necessity, for economical reasons, to produce as much food as possible for their own needs. Where labour is plentiful, machinery is required to supplement it and increase the supply of grain, and elsewhere machinery alone has enabled the land to produce enough for the needs of those who live upon it. The work has to be done economically, because cheap produce is the basis of national prosperity, and if the prices of essential commodities are kept down there is less risk of inflation of values generally; in some countries the price of bread is regarded as an index of living cost. The agricultural engineer is therefore engaged upon one of the most important and pressing tasks of providing for the requirements of the whole of mankind, but it is a task that needs all his energy and enterprise to carry through, for the reason that the industry is no longer specialised by a few countries, but has spread its ramifications over the greater part of Europe. Having undertaken to develop agriculture, each country has aimed at manufacturing all it can for the needs of farmers. Notwithstanding the requirements in machinery, which are growing and will continue to grow, the agricultural engineer is faced with increasing competition and the difficulties incidental to protective tariffs. He must produce cheaply and organise for sales against strong combinations abroad, and it is a matter for concern that English manufacturers of agricultural machinery, who, in Europe, hold the lead in this branch of engineering, should continue to find themselves in an extremely difficult situation through being unable, as is the case with their foreign competitors, to profit from the large requirements of a prosperous home agricultural industry to dispose of their machines under competitive conditions abroad. No one has done so much for technical progress in agricultural machinery as the manufacturer in this country. With few exceptions every description of farm mechanism in common use is of British origin. Our manufacturers laid the foundation of a world-wide industry, and they always enjoyed an unrivalled reputation for the quality of their products until economic causes ousted them from some foreign markets. The conditions of agriculture have also changed, involving new methods and a continuous search for new mechanical appliances, and the efforts being made by foreign manufacturers to meet these modern conditions give interesting, though not always satisfactory, results. Great Britain is not behindhand in this work of research. The Institute of Agricultural Engineering at Oxford and the various other agricultural technical bodies are laying the foundation of a new practical science which will open up fresh departures in the design and construction of machinery. This means the application of the science of agriculture to engineering, whereby machinery can be produced that will more perfectly meet new requirements. This, unfortunately, does not solve the economical problems that beset the English manufacturer. He may produce the best, but he must be provided with the same facilities as those possessed by his foreign competitors if he is to be given a fair chance to recover some of the home and foreign trade.

The extent to which the agricultural engineering industry has grown during the past decade in countries like France, Germany, Czechoslovakia, Italy, and other countries was revealed at the annual agricultural machinery show in Paris. This is claimed to be the largest and most comprehensive in the world, though probably rivalled by the German show, and the exhibits indicated that continental makers are determined to supply all they can for the needs of agriculture. Those needs are growing, because farmers must have machinery if they are to till more land and grow heavier crops. Once scientific methods are more generally adopted in the way of growing those crops most suitable for the soils, seed selection, fertilising, drainage, and irrigation, and, more especially, methods of tillage, the demand for machinery will grow, and new machines will be required for the harvesting and gathering in of particular crops. One example of this is the urgent need of a machine for lifting and laying out beet in a way that will allow of its being carted away direct to the sugar factory. The substitution of machinery for hand labour can alone enable the continental beet industry to recover from its present economical depression. For years past many machines have been designed for lifting, topping, cleaning, and laying the beet out in rows. They have all failed because they could not work under all conditions of soil, sometimes hard and sometimes heavy and adhesive, and their construction was too mechanical and too costly. At the Paris Show a new beet harvester, which is declared to have given quite good results during the late beet harvest, was exhibited. It deals with the beet in the same way, first by bringing down the tops to a knife which cuts them, then lifting the roots by converging shares and conveying them up on to screens which clean them and drop them in rows at the sides. All this is done by a simple arrangement of chains, sprockets, shafts, and bevel wheels carried well above the frame, where it is out of the way of soil and obstructions. This design points to a possible solution of the problem, but it is not the only one, for in this country a beet harvester has been introduced that is claimed to give satisfactory results. Another problem, offering less difficulty, is the flax-pulling machine, which is needed in order to revive the flax-growing industry. The British and Belgians are ahead in this branch of mechanical construction, and there are at least two machines of a practical type, and another was shown in Paris by a French maker, with the endless band-pulling mechanism actuated by a petrol engine. These examples are given to illustrate the scope that exists in the agricultural industry for new machines that are necessary to a more economical development of cultivation. They are often costly to introduce, and experience has shown that they must be of economical construction, but there is certainly a considerable opening for labour-saving machines for operations requiring an occasional supply of hands that is not always procurable.

From the point of view of English manufacturers, the Paris Show revealed the productive power of the continental industry and its continual effort to meet new requirements. Each country

regards agricultural implement manufacture as a national industry, and in each it is being protected and encouraged. Thus markets are slipping from English makers, who can only regain them with some sacrifice or by introducing improvements or new machines that will allow farmers to realise economies. There is little advance in the ordinary classes of machinery, such as grass mowers and binders, thrashers and barn machinery, and progress lies more particularly in increasing the capacity of those machines with the use of motive power. The combined harvester-thrasher can only be employed satisfactorily on large estates, such as those in North Africa, where vast areas are put under cereal crops and where labour is scarce. The tractor has become an essential part of the equipment of medium and large size farms, and efforts are being made to provide tractors suitable for the small husbandman and even for the market gardener. Agriculture is rapidly becoming industrialised, because the rural population is diminishing and more land has to be cultivated. The tractor is regarded as offering one solution of the problem. Another is electrification, but it is hardly likely to extend to field operations which can be more conveniently carried out with mobile and independent vehicles. Thus, the tractor industry is growing steadily, and at the Paris Show it was again evident that developments are taking place in the direction of the adoption of heavy oil engines, particularly of the hot bulb type. The Germans again exhibited such engines, mostly with solid injection, and the French believe that they themselves are getting over the difficulties of building engines which will be reliable in the hands of the ordinary user. Small power units were numerous, mostly for light tillage implements, and the motor plough is gaining ground now that makers of petrol engines are adapting them to that purpose. Agriculture is, in fact, offering a very wide field for the application of motive power and the employment of new machinery involving new methods of effecting economies. The problem has to be approached by the engineer from the point of view of economy, alike of construction and use, and economy naturally implies efficiency with the aid of the simplest means. For the Colonies, the difficulties to be overcome are generally not so great, but they are special in view of exacting conditions, and it is here that English makers will probably find a great scope for their activity, for reliability and efficiency are paramount, and quality cannot be sacrificed. In Africa, the opening for agricultural machinery on the large corn lands and the cotton and other planatations, which it is hoped will be created in the near future, will be considerable. There is much to be done by English firms, and there is no reason why, apart from the highly competitive harvesting machinery, they should not improve their business outside those countries where heavy import duties are levied for the protection of native industry. It would be better if more were known abroad of the technical progress that is being accomplished in this country.

Protective Gear.

THE paper on "Recent Developments in the Protection of Three-phase Transmission Lines and Feeders," read before the Institution of Electrical Engineers by Messrs. T. W. Ross and H. C. Bell, is to be regarded as an instructive and important contribution. The field covered is far too wide and complicated to permit of detailed consideration here, but the fact should be emphasised that the authors have shown that even under the present, and difficult, conditions it is possible to obtain stable and discriminative protection. As supply engineers who are called upon to select protective gear to meet specific requirements find themselves faced with a bewildering array of relays and different ypes of gear, a paper which throws light upon the objects of the various schemes that have been evolved can scarcely fail to prove useful. The vast difference between old and new conditions is well shown in a paper on the Electrical Distribution System of Manchester, read by Mr. H. C. Lamb before the Manchester Association of Engineers. For the first seven or eight years distribution was carried out in Manchester without any safeguard against short circuits, as all the mains were connected up solid to the generators without fuses or circuit breakers. When faults occurred—and there were many—the machines groaned, the brushes sparked, and the men on watch held their breath, and hoped the fault would quickly burn itself clear. On the indication of a fault, hansom-cabs were hastily requisitioned in order to disconnect the faulty mains at the pillars in the street manholes. On one occasion at least the short circuit was so severe that the generating station had to be shut down until the fault had been located and removed. As the amount of power distributed increased, it became impracticable, as in other places, to continue this heroic though somewhat barbaric method, but there were many stages to go through before the elaborate methods of to-day for the protection of high-tension mains were perfected. In spite of the grading of fuses and circuit breakers the discrimination obtained was entirely inadequate. The attention of designers was consequently focussed on the problem, with the result that many devices were invented for securing the necessary discriminative action. For their operation these devices mainly depend on the out-of-balance fault currents induced in the secondaries of small transformers in series with generators or mains.

On a big system the scheme of protection at different points is necessarily complicated. Modern conditions of electricity supply have set designers of protective gear many difficult problems, which, however, appear to have been satisfactorily solved. While in this country balanced protective gear has been practically standard for the short feeders that have hitherto been in service, the greater distances which feeders now have to cover render in many instances the use of pilot wires and special cables prohibitive, and other schemes which do not require these wires or cables have to be adopted. Every case of protection must, of course, be considered individually. As Messrs. Ross and Bell show, it may be necessary to take into consideration the possibility of a feeder-breakdown, the existence of alternative routes of supply, the importance of the load, the liability of a fault to cause excessive disturbance, and other special conditions. The brief abstract of the paper published in this issue shows mainly the conditions that now have to be met, whilst the paper itself describes and illustrates the various systems of protection which have been developed to grapple with these conditions. That great ingenuity has been brought to bear on the matter is obvious from a study of the paper. The method described of overcoming the effect of arc resistance on systems protected with impedance or distance relays is, for instance, interesting and ingenious. The principle which governs the design of all impedance relays is that the relation between the fault current and voltage at the point where the relay is connected depends upon the impedance of the feeder or line between that point and the fault. There is, however, a practical difficulty in applying such relays, as owing to the variable resistance of the arc, it is impossible to estimate correctly the exact impedance of the feeder. But a simple and effective method has been found of overcoming the difficulty. An adjustable resistance is connected in series with the current coil of the relay and the potential drop across this resistance is applied to the restraining coil in such a direction that it opposes the resistance component of the impedance voltage. By adjusting the value of the resistance, it is possible entirely to compensate for the resistance component of the impedance of the line or feeder and to reduce the error due to the maximum variation of the arc. Of the pilot wire systems of protection described in the paper, one of the most interesting is the "Translay" system, which avoids the use of pilot sheaths. The danger of inaccurate relay operation, owing to capacity currents in pilot cables, is avoided without the use of expensive sheathed pilots, whilst, as the pilot current only has to supply a small portion of the energy required for relay operation, heavy pilot wires are unnecessary. Another interesting development described is the use of copper oxide rectifiers on direct-current pilot wire systems, a scheme which offers the advantage that batteries of equal voltage are dispensed with, as the direct current for the pilot circuit is supplied from the protective transformers through the rectifiers. Some time ago a scheme of this kind was demonstrated at the works of a well-known electrical firm, but up to the present the idea does not appear to have met with practical application. While doubts have been expressed as to whether the rectifiers would always prove reliable, Messrs. Ross and Bell maintain that they should be practically everlasting, for a saturated summation prevents an over-voltage being applied to the copper oxide film. The rectifiers are, moreover, only connected to the supply during fault conditions.

The paper naturally does not describe all forms of protective apparatus. Both in this country and abroad the subject has received a vast amount of attention, and in America a carrier current differential protective system has been devised for transmission lines, in which the mere passage or cessation of a carrier current is the determining factor. The presence of a carrier current signal indicates that the line is in order, and prevents the circuit breakers operating, whilst the interruption of the carrier current as the result of a fault causes the breakers to trip. The system obviously does not involve the use of pilot wires. It constitutes a radical departure from orthodox ideas, but whether it has been tested under actual practical conditions we do not know. Although considerable development has taken place in carrier current communication over power lines, the degree of reliability acceptable for a telephone system would scarcely be sufficient for protective purposes. It does not follow, however, that the idea is unsound. Ingenious and reliable as many of the protective systems are, it would be folly to suppose that the state of finality has been reached, and all new systems, even if they depart widely from orthodox practice, should receive the fullest consideration. In the future new requirements will no doubt make further demands on the skill of protective gear designers, but it is to be hoped that the desired results will be secured without additional complications.

Literature.

Gaseous Combustion at High Pressures. By Professor WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., DUDLEY M. NEWITT, Ph.D., D.I.C., and DONALD T. A. TOWNEND, Ph.D., D.I.C. Longmans, Green and Co. 1929. Pp. 396, folio.

THE authors apologise in the preface for the book "being chiefly devoted to their own researches," but the reviewer feels that this modesty is quite unnecessary, as the work described is in scope and elaboration of methods for overcoming great difficulties successfully almost unique in these days. The Imperial College of Science and Technology is to be congratulated upon having confided its high-pressure gas research laboratories to such able workers.

It is rather curious to contemplate how quantitative chemistry became a science some 150 years ago through the study of combustion under ordinary conditions, and how at this moment an altogether new chemistry is being evolved by the experimental study of combustion under more or less extraordinary conditions of pressure, &c. Without calling it a combustion, the authors choose the synthesis of ammonia from hydrogen and nitrogen as a first illustration. In this short citation—two pages in all—they show how hydrogen burns in nitrogen or *vice versâ* to ammonia under the influence of high temperature and pressure through excitation by a catalyst, just as Deville had shown that they behaved at ordinary temperature under the influence of the electric spark in the presence of sulphuric acid for removing the ammonia as formed. This example of high-pressure synthesis and one other in the introduction serve to lead up to a discovery made during their experiments, as the other examples foreshadow their observations on the deviations from Boyle's law, &c. Other parts of the introduction mention important work done previously to the work at the Imperial College.

The chapters describing the laboratories at the Imperial College are brimful of detail and intended for close study. A valuable section of these pages emphasises the risks attendant to this class of work and gives hints as to precautions to be taken as well as the regulations adopted at that institution. There is this to be said about precautions and regulations in general: that when they are applied to a case like the one of an inexperienced beginner—page 15—who "tried an unauthorised experiment in the temporary absence of the experienced research assistant under whose supervision he was working," the most serious breach was the absence of the experienced man. Another tort, to use a legal expression, is chargeable to the seat of learning which imparted knowledge without the keen sense of honour and discipline, which is just as necessary to a scientific investigator as the other, to the young man in question. It is very often the case that the most brilliant scholars at the universities are, when they leave, quite hopeless as experimenters, and possessed of less serious traits of character through being "petted" than their less gifted comrades, who have to work hard to "get there." Any director of dangerous research should remember this, and see that such valuable intellectual assets require careful guidance to become useful to mankind without danger to others. With regard to the sad accident to Mr. W. A. Haward, who was killed by the bursting of a Bourdon pressure gauge, one would think that all such gauges should be protected all round and read through a parallel mirror system by telescope in comparative safety. These very high pressures do, as the authors point out, involve great danger even during small-scale experiments, and the industries based upon eventual dis-

coveries look to the pioneers for guidance with regard to safety arrangements. The query is: has everything conceivable been done? There is an even more dangerous field of research, in which the workers number thousands, viz., high-tension electrical investigations, and the accidents in that field are, at least in laboratories, very few. Is the reason that in this case frivolity or faulty precautions mean nothing less than sudden death? Compressed gasses of all kinds from carbonic acid, acetylene, liquid air, &c., have all, on the contrary, claimed their victims amongst investigators. Why is this?

The authors' descriptions of the testing of materials, of the construction of bombs, &c., as well as of the details of instruments used, are all worthy of the closest study. Everything thus described has actually been tried under the severest shocks well-nigh thinkable, and the bombs and instruments have given the performances expected from them. Future investigators have, hence, in this book a reliable guidance in their work. Some of the bombs used were designed by Sir J. E. Petavel, who did early work on explosion pressures and also designed a recording pressure gauge for use with these bombs. The constructional details of these bombs show an archaic simplicity, the dimensions of explosion chambers, &c., being mostly even inches, screw plugs are standard Whitworth sizes, &c. &c. The authors certainly give surface: volume ratios and discuss their significance—page 75. In this short section they mention cases in which they find what they call the period of the Petavel pressure gauge too great for time recording, and the reviewer thinks that, may be, all the curves given will one day be found to be affected by "lag." Pressure gauges are treated in Chapter VI. in an excellent manner, but it is questionable whether the Petavel high-pressure time recorder is accurate enough for giving very reliable numerical results It is essentially a piston held in position by a very strong spring allowing a very short traverse for the highest pressures, a particular form of tilting mirror mechanism being used for photographically recording the movement. However small the momentum of the piston may be, there is also a lag in the return of the spring, and minor characteristic points, which from chemical reasons should appear, get swamped by the general major movement. The problem of constructing a recording pressure gauge of this kind is extremely abstruse, and it is highly creditable to have produced even an approximate instrument like that of Sir J. E. Petavel's, but, perhaps, one day we shall be able to produce an electrical P.D. proportional to pressure only, or perhaps a variable contact between discs minus temperature coefficient allowing pressures to be estimated without lag. Who knows?

There is no possibility of examining all the experimental details of the authors here, even superficially, but it may be added that sometimes quartz windows were employed for spectrographic recording of the spectra of the gases during the explosions fairly well into the ultra-violet.

The objects of the researches described were many and important. A great deal was known about the deviation of gases from Boyle's law during isothermal variation of pressure—pages 48 *et seq.*—and also with regard to deviations from Dalton's law of partial pressures for mixtures of gases under similar conditions. The authors have extended these considerations to the case of original volume for correcting pressure curves for explosions of gas mixtures, and also determined the effect of varying the initial pressure. They have also studied the reaction between nitrogen and oxygen, when exploding mixtures of air and carbon monoxide with high initial pressures. As a matter of fact, they give some prominence to this part of the research as being a possible practical issue. From a theoretical point of view it is interesting to note that they found that mixtures of rigidly dried gases, which did not explode at ordinary pressures, exploded easily when the pressure was increased beyond a certain limit. Engineers will be interested in the work on hydrocarbon air mixtures, giving upper and lower limits for richness of the mixtures and their variation with the initial pressure. The authors have paid attention to the influence of steam and hydrogen upon high-compression explosions, and they have tried helium and argon as diluents. Through it all it is left to the reader to guess at the plan underlying the research which must have been modified by the data found from time to time.

The chapters devoted to the interpretation of the results are debatable on account of the necessarily limited accuracy of the pressure: time graphs; but it is interesting to note the methods of reasoning adopted for calculating maximum temperatures and other data appertaining to the energetics of the explosions. On the whole what is given is simple and non-pretentious and apparently of a preliminary nature. The summary on page 238 is of great interest to engineers. It treats the appearance of "knock" effects in exploding CO+air mixtures containing hydrogen above 0·65 per cent. and its disappearance when raising the temperature of the bomb above 100 deg. Cent. The authors assume the effect to be "catalytic," and the reviewer thinks their view can be supported by applying the peroxide theory, in which case the higher temperature lies above the temperature at which the peroxide exists.

All the results are carefully tabulated and good blocks and graphs illustrate this highly interesting volume. An illustrated description of the Bone-Newitt gas analytical apparatus is found at the end. The reviewer recommends to power engineers to study this apparatus carefully, as a good operator can by its means make an accurate analysis of a gas mixture almost as rapidly as with an Orsat apparatus giving debatable results.

Summarising, it may be said that this book is a record of experiments and their results, these experiments being made under conditions which already exist in practical machines up to certain degree, and for elucidating what actually takes place during explosions under high initial pressures. Being pioneers' work, the order in which the various facts and speculations are put down is somewhat erratic, and to see the immense value of the information given the reader must carefully go through the whole story. From this reason it is not a text-book in the ordinary sense, and to make it useful as a work of reference it requires a companion volume outlining the facts given briefly with reference to the places where the details are to be found in this exhaustive description of the lot. One of these days the subject, which now appeals to the few only will be a necessary adjunct to an engineer's education, and then probably this work will become an often seen classic.

The book is well printed and easily read, and it is to be highly recommended to internal combustion engine makers and engineers as well as to the scientific reader.

Australian Imports of Machinery.

THE following remarks upon Australian imports of machines and machinery are taken from a report upon the "Economic and Trade Conditions" by Mr. R. W. Dalton, which has just been issued by the Department of Overseas Trade, price 4s. 8d.

The total imports in this class in 1927–28 were valued at £16,209,045, as compared with £16,640,186 in the previous year. In 1928–29 the value fell to £14,566,740, largely owing to heavy decreases in imports of cables, dynamo ~~-~~electric machines, telegraph and telephone appliances, motive power, machinery and sewing machines. The growth of this trade since pre-war years is an illustration not only of the large increase in the general absorptive capacity of the country but also of the effect of the development of local industries in diverting trade from goods themselves to machines and machinery for the manufacture of goods. The trade in 1913 amounted in value to £4,841,000, of which the United Kingdom secured £2,547,000, or 52·6 per cent., and the United States £1,435,000, or 29·6 per cent. By 1927–28 the trade had increased to a value of £16,209,045, of which the United Kingdom secured £8,708,938, or 53·7 per cent., and the United States £5,418,147, or 33·3 per cent.

On the surface, therefore, it would appear that the position has continued fairly satisfactory from a British point of view, for not only had the turnover from the trade increased enormously, but the British percentage has remained fairly constant. Moreover, the advantages which the United States secured during the war do not seem to have made a very great difference in her ultimate percentage of the total post-war trade. On closer examination of the details of trade in individual items, however, there do appear certain unsatisfactory features. Details have been taken out of the statistics of goods in which there is severe competition from foreign countries. The total trade in such goods amounts to £9,614,384 out of the total trade in the class of £16,209,045 in 1927–28; of this trade the United Kingdom secured a total of £3,432,402, or about 35·8 per cent., while of the remainder of the trade in the whole class (£6,594,661) she secured no less than 80 per cent. It is significant, too, that out of the trades in this class in which there is severe competition (*i.e.*, £9,614,384) the United States secured trade to a value of £4,578,371. Thus in that part of the trade in this class in which there is severe competition (which is about 59 per cent. of the total imports in the class) the United States secured more than a million pounds of trade more than the United Kingdom, and no less than 47·7 per cent. of the total; of the remainder of the trade in the class (*i.e.*, £6,594,661) the United States secured only £839,777, or less than 13 per cent. The further interesting fact appears that out of the trade in this class in which there is severe competition (viz., £9,614,384) the United Kingdom and the United States together secured £8,010,773, or nearly 84 per cent., while of the trade in which there is not the same severity of competition with the United Kingdom (viz., £6,594,661) these two countries together secured £6,116,313, or nearly 93 per cent. Two things become obvious, therefore, that the competition which is to be feared in this class comes almost entirely from the United States, and that though the severity of that competition is felt in a restricted number of items, it is extremely successful in those items to the extent even of surpassing in its total results the results secured in the same items by the United Kingdom.

It is most gratifying to be able to record, however, that while the total trade from the United States in this class decreased in 1927–28 as compared with 1926–27 by over £900,000 (from £6,367,000 to £5,418,000), the trade from the United Kingdom increased by over £400,000 (from £8,269,000 to £8,709,000). It is interesting to note, too, that whereas imports of electrical machinery and appliances from the United States declined by about £460,000, imports of these goods from the United Kingdom increased by about £100,000. There was also a very large decrease in the imports of printing machinery from the United States combined with an increase of over 50 per cent. of the imports of this class of machinery from the United Kingdom. Other important decreases in the imports from the United States in this class were in cash registers, dairy implements and machinery, metal working machinery, sewing machines, typewriters and knitting machinery. The only important increase in imports from the United States was in agricultural machinery (chiefly reaping machinery).

Of other foreign competition in this class, the total of which amounted to about £2,100,000 in 1927–28, Germany supplied £616,221, the largest item being in electrical goods; Canada £481,307, chiefly in agricultural machinery; Holland, £320,302, chiefly in electric lamps, and Sweden £209,096, chiefly in cream separators and electrical machinery.

Much the most important trade in this section is that in electrical machinery and appliances, the total of which in 1927–28 amounted to just over £7,000,000 (declined to just over £6,000,000 in 1928–29). The trade has increased since 1923–24 from about £4,800,000, and it is pleasing to note that the share secured by the United Kingdom has grown from 65 per cent. to 67 per cent. between the years 1923–24 and 1927–28; on the other hand, the share of the United States has declined from 26 per cent. to 21 per cent. Cables and wire accounted for £1,721,000 (£1,317,447 in 1928–29) of the trade in this branch and the United Kingdom gets practically the whole of that; but leaving cables and wire out of account, the share of the United Kingdom has still shown an increase from 54 per cent. to 57 per cent. between the years 1923–24 and 1927–28. It is significant in this branch of trade, too, that there are certain more or less speciality lines in which the United Kingdom makes a very poor showing, and if it were not for the success of foreign competition in these lines the United Kingdom's share of the total trade would be very different from what it is. For instance, while the United Kingdom during the past few years has materially improved her relative position in heavy lines such as dynamo electric machines and regulating and starting apparatus and the like (mostly at the expense of the United States), she has still failed to secure more than a secondary position in the trade in such lines as wireless material, batteries and heating and cooking appliances.

The trade in agricultural machinery is still extremely unsatisfactory so far as the United Kingdom's share is concerned, nor is it likely to be anything else until some organisation appears on the field which is capable of selling by the same methods which have been adopted by American and Canadian suppliers. Apart from the fact that British machines in this trade are not always suitable for Australian conditions, the trade is almost entirely "terms" business and sales and collections demand an efficient and widely scattered sales organisation. The import trade in agricultural machines themselves is not now very great compared with the sales of locally manufactured lines (in 1927–28 it was valued at only £679,323, of which the United Kingdom secured only £96,103), but the range of goods which could be sold to the farming and pastoral classes through such an organisation is much wider than that covered by the expression "agricultural machinery." For instance, the tractor trade alone was worth in 1927–28, £1,166,155, of which the United States secured £1,043,859 and the United Kingdom only £61,977. Certain tractors of British manufacture are now being placed on the market which embody the main features of the American tractors which have been so successful, but this alone will not suffice to secure any considerable portion of the trade, and unless a selling organisation is put in which can compete with existing organisations which are already well entrenched, no important change in the present distribution will be seen. Widely extensive ramification of selling organisation, intensive propaganda, both by advertising and by use of exhibition, sales on a time payment basis and expert service after sale will all be essential before success in this trade can be expected. Even so, there is a prejudice of long standing to break down and the existence of this prejudice, coupled with satisfaction by experience with tractors already on the market, mean that any new tractor placed on the market begins with a handicap which only persistent effort, combined with efficiency in working and satisfactory "service after sale," can overcome. This trade is by far the most unsatisfactory trade in this section from a British point of view. In the five years from 1923–24 to 1927–28 it represented a total value of over £5,000,000, of which the United Kingdom's share was less than £700,000.

In metal working machinery (trade valued at £509,574 in 1927–28) the share of the United Kingdom has declined from 58 per cent. in 1923–24 to 46 per cent. in 1927–28, and that of the United States from 35 per cent. in 1923–24 to 31 per cent. in 1927–28; these declines are due largely to the return of Germany to the market.

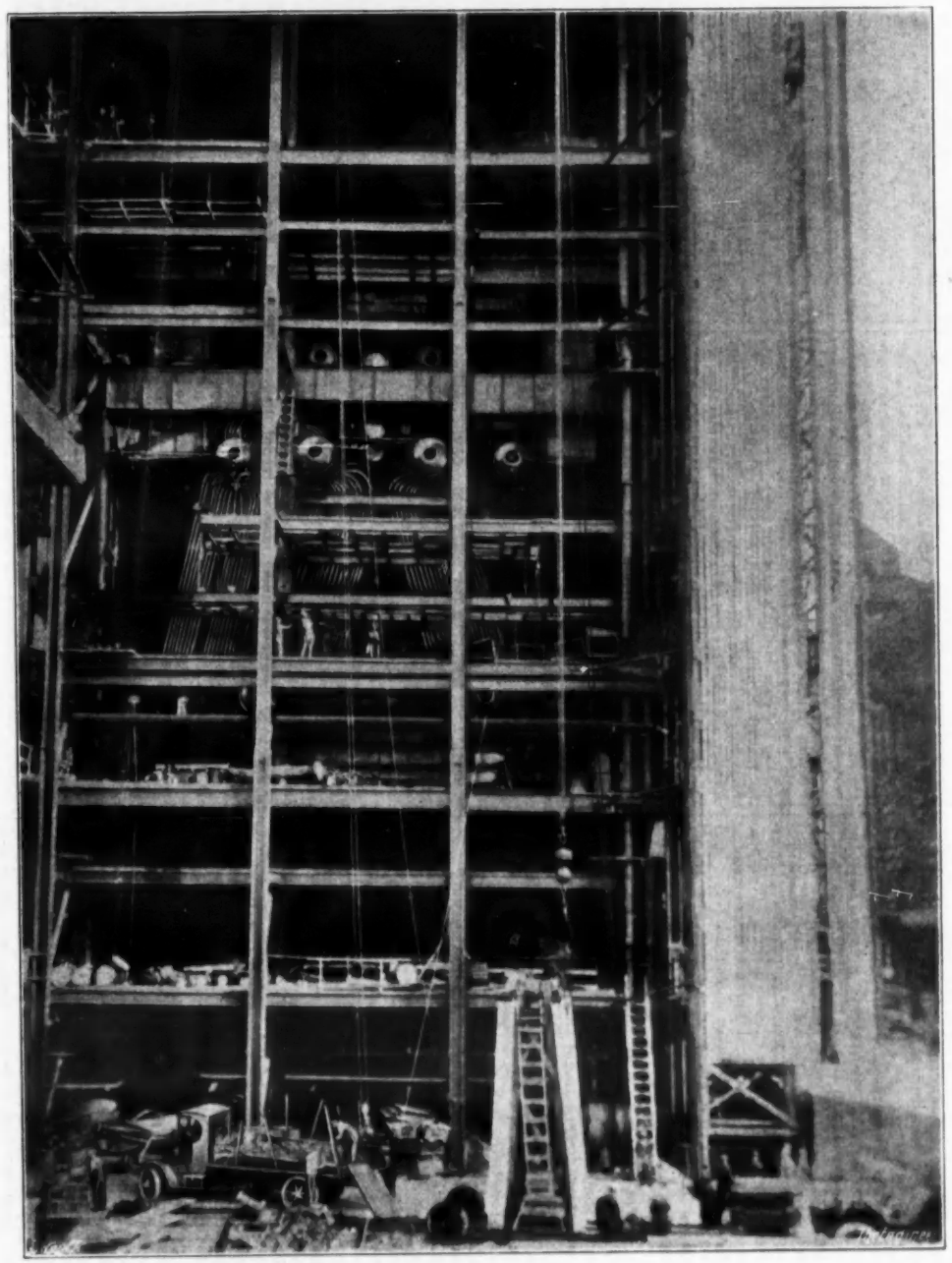
Writing of these statistics in his introduction, Mr. Dalton says:—"A reference to the import section of this report will show clearly the nature of the goods in which Great Britain's trade is so unsatisfactory. It is not at all uncommon for British manufacturers to imagine that the limitation of their trade with Australia is due in the main to protection of Australian industries. This may be true to some extent, but so long as there is such an important portion of the trade in which Great Britain has only been able to secure 30 per cent., when her share of the total competitive trade of Australia is over 57 per cent., and her share of one-half of it is over 85 per cent., it is obvious that there must be ample scope for an improvement of the total of British imports into Australia in the section in which her trade is so unsatisfactory. If foreign firms can succeed to such an extent in these classes of goods, it is obvious that it is not the tariff alone which is limiting Great Britain's trade with Australia, and that, as a result of closer investigation of conditions and the exercise of greater effort, there is still room for considerable addition to British exports to this market. As is pointed out in the import section, if Great Britain had been able to secure even one-half of the trade in what is called "severely competitive trade," her share of the total competitive trade of Australia in 1927–28 would have been nearly 70 per cent. instead of only 57½ per cent., and the added value of production in Great Britain through this small change alone would have been over £10,000,000. The obvious inference to be drawn from this is that even if, for reasons stated above, the level of import trade in Australia remains below the level which it reached in 1926–27, there is still an excellent opportunity for the increase of imports into Australia from the United Kingdom.

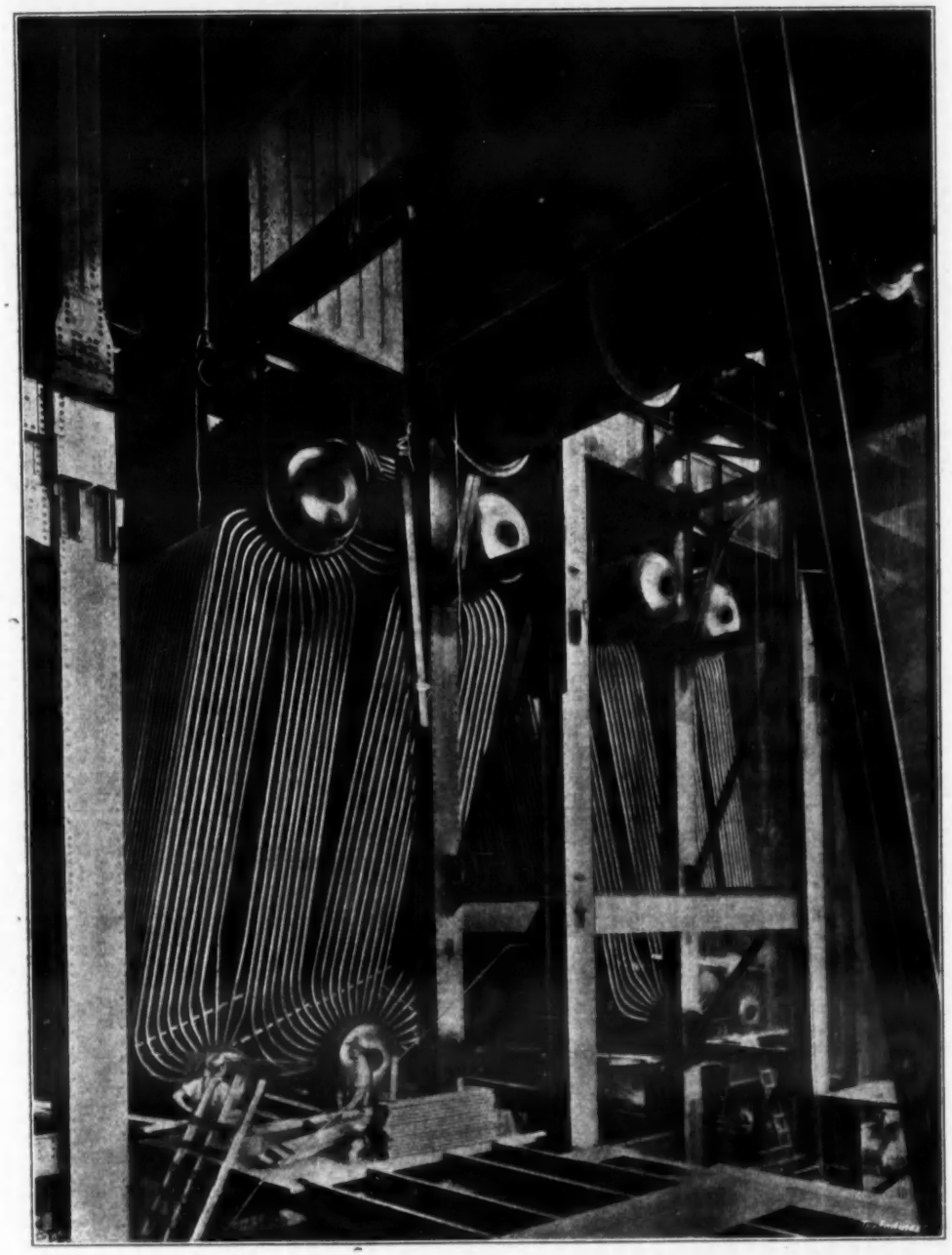
IT is proposed to develop a free port at Henngchow, near Macao, China, at a cost of about £400,000.

LADD BOILER AT THE EAST RIVER POWER STATION, NEW YORK

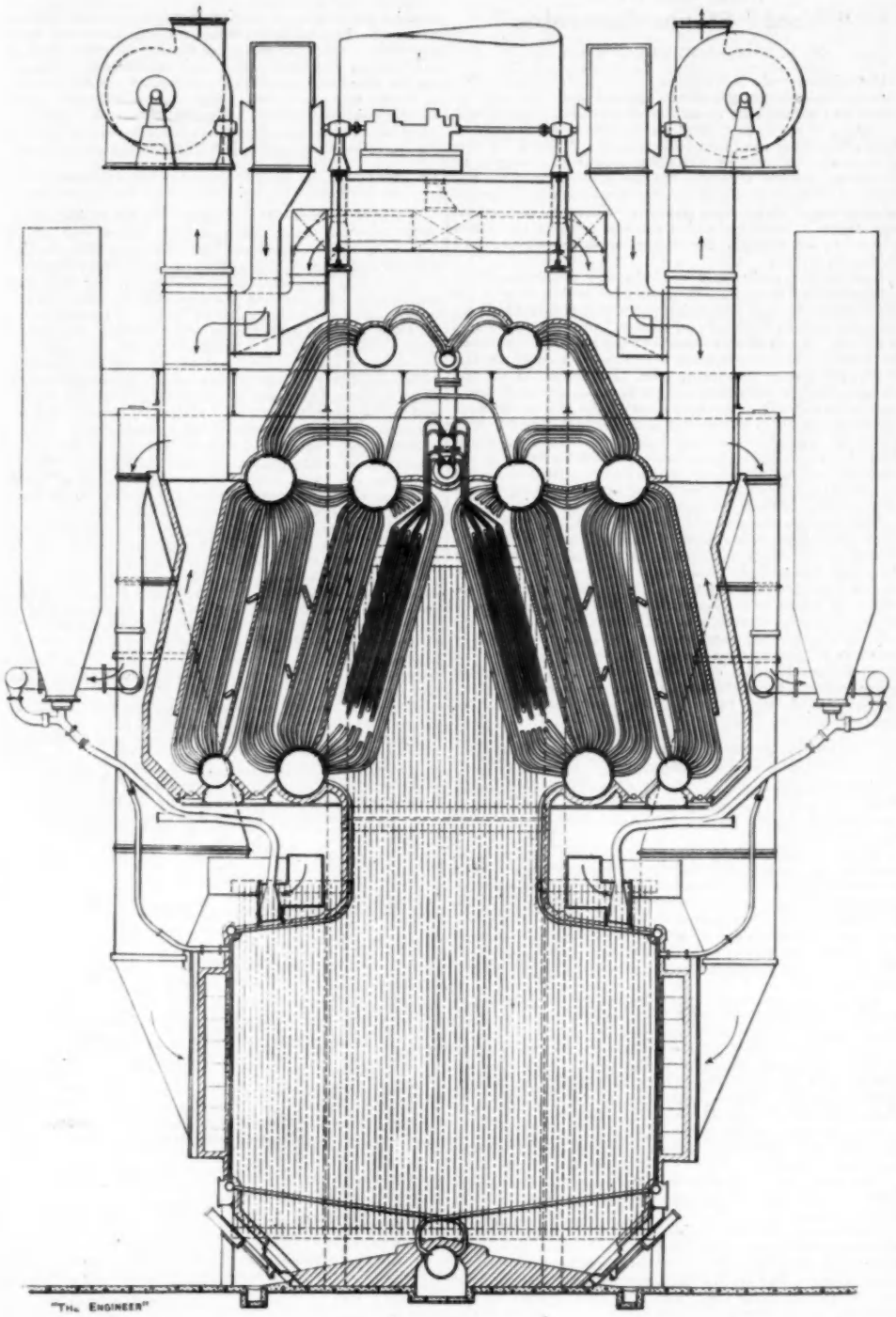
THE COMBUSTION ENGINEERING CORPORATION, NEW YORK, ENGINEERS

(*For description see opposite page.*).





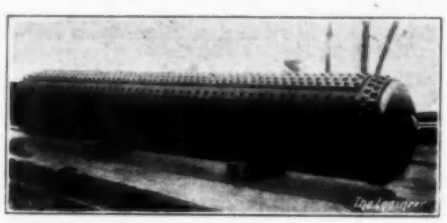
LADD BOILER—EAST RIVER POWER STATION, NEW YORK



The Largest Boilers in the World.

AT the meeting of the Institution of Mechanical Engineers on Friday last, reference was made to the enormous boilers which have been recently erected in the East River Station of the New York Edison Company, and some further particulars and illustrations may be welcome.

There are three of them, and their guaranteed maximum



STEAM DRUM

capacity is 800,000 lb. of water evaporated per hour each, but information just received is to the effect that one boiler has reached the enormous evaporation of 1,250,000 lb. per hour. It is interesting to note that the cost of the three generators with their auxiliaries is about £1,100,000, or, in round figures, 6s. 8d. per pound of evaporative capacity per hour. The three boilers are identical and the principal dimensions are given below.

Each boiler has 3786 tubes and ten drums, the largest drums being 54in. in diameter, and each of them weighs 65,000 lb., or over 29 tons. The coal consumption at full capacity is about 36 tons per hour.

The boilers are of the Double Ladd type, with integral economisers, and the furnaces are completely water-walled with fin tubes. One of our illustrations shows

LUNCHEON PARTY IN FURNACE

a luncheon party for ninety people taking place in one of the furnaces. The wooden floor was built up 10ft. from the furnace bottom, and was 43ft. 6in. long by 23ft. 6in. wide. The steam drums were 85ft. above the heads of the guests. The Lopulco pulverised system is employed, the supply of fuel being taken from storage bins. The powdered coal enters through rows of vertical burners, but beneath each of these burners there is a smaller horizontal burner. It has been found that this arrangement causes very complete and rapid mixing of the coal and air, and the intense local heat causes very rapid ignition of the fuel. All the air used is preheated by the flue gases in two C.E. plate type heaters, each of which contains more than an acre of heating

INTERIOR OF FURNACE

surface. The rate of combustion is between 26,000 and 30,000 B.Th.U. per cubic foot of furnace volume per hour.

Boiler heating surface	60,706 sq. ft.
Water heating surface in furnace	7,345 sq. ft.
Superheater surface	13,900 sq. ft.
Air preheater surface (effective)	82,721 sq. ft.
Furnace volume	38,200 cu. ft.
Design pressure	500 lb.
Operating pressure	425 lb.
Total temperature of steam	725 deg. Fah.
B.Th.U. liberated per cu. ft. of furnace volume (max.)	25,300
Maximum continuous steam output	800,000 lb. per hr.
Feed water temperature	360 deg. Fah.
Air temperature leaving air preheater	432 deg. Fah.

The boilers were designed by the Combustion Engineering Corporation, and erection began on June 1st, 1929; four and a-halt months later the first unit was under operation and the last early in December.

The Protection of Three-phase Transmission Lines and Feeders.

THE protection of transmission lines and feeders has given rise to a great deal of ingenious work and, as shown in a paper on this subject read by Messrs. T. W. Ross and H. C. Bell before the Institution of Electrical Engineers, supply engineers who are called upon to choose protective gear to meet specific requirements find themselves faced with a bewildering array of relays and different types of gear. Perhaps in no other branch of electrical engineering has so much ingenuity been displayed as in the design of protective systems and devices, many of which have been tested under practical conditions. Within the last fifteen years the science of correctly protecting machines, transformers and feeders so as to combine the necessary sensitiveness with stability has been gradually developed, and the methods successfully applied to smaller machines and transformers have been found to apply with slight modifications to the larger units used to-day, but the extension of high voltage networks has introduced new factors into the problem of feeder protection, and the methods hitherto employed are no longer suitable for many extra high-tension feeders. The exceedingly heavy faults which occur in the large networks of to-day have considerably increased the difficulties of feeder protection. The fault currents are carried by healthy sections as well as by the faulty sections, and it becomes necessary to provide balanced gear that will remain stable, or other discriminative gear which will retain its correct discrimination with the heavy through currents now experienced. These heavy fault currents demand at the same time protective gear that will provide for rapid clearance, not only on account of the damage that may be caused in the neighbourhood of the fault, but also to diminish the liability of synchronous plant falling out of step.

The extension of feeder networks, combined with the higher voltages at which they are operated, has, moreover, resulted in larger charging currents in the lines and cables, and when balanced protective gear is in use these currents are of importance as they represent under healthy conditions an out-of-balance similar to that which exists during a fault. During fault conditions, these currents also assume higher values in healthy feeders, owing to the rapid voltage change which sets up transient disturbances of frequencies much higher than the normal. Other currents are induced in, or find their way into, the pilot cables, and for satisfactory stability, balanced systems of protection must be compensated for all these conditions.

Another point to be remembered is that instead of receiving a supply from a single point many feeder networks

now have a number of feeding points, and, as a consequence, the direction in which fault currents may flow in certain of the feeders depends upon the position of the fault on the network. For these and other reasons the design of protective gear to meet modern conditions calls for a good deal of consideration. The increasing complexity of feeder networks introduces new difficulties into the forecasting of the distribution of fault currents in the various feeders under all conditions, and in many cases very careful computations are necessary. The care required in the correct relaying of a complicated system will be appreciated when it is remembered that the opening of a switch at one end of a faulty feeder may cause a complete redistribution of fault currents in the entire network. Moreover, in certain cases, in which the capacity of connected generators may be varied considerably, fault currents at times of light loads may actually be less than the normal load current under maximum load conditions, and special schemes must be provided to meet such requirements.

To consider all the schemes dealt with in Messrs. Ross' and Bell's paper is out of the question. The paper itself does not, in fact, describe all the systems in detail, but an attempt is made to indicate the lines along which modern protective methods are developing, and to set out the relative merits of each. Before the correct choice can be made for any particular case, however, full consideration of all the special circumstances must, of course, be made, and operating engineers must to a large extent use their own discretion. The capital cost and maintenance charges on protective gear are generally regarded as a type of insurance, and the amount of money allocated for it will be largely determined by the value placed upon the continuity of supply at all points. The additional expense of pilot wires for certain protective schemes cannot, in many cases, be justified, and other discriminative schemes may have to be substituted. It may be necessary to take into consideration the liability of a feeder to break down, the existence of alternative routes of supply, the importance of the load, the liability of a fault to cause extensive disturbance, and other special conditions. Balanced protective gear has been practically standard in this country in the past for the short feeders that have been in use, but the greater distances which now have to be covered by feeders often render the use of pilot wires and special cables prohibitive, and non-pilot systems must in many cases be adopted.

The various methods of obtaining discriminative protection are reviewed in the paper. Commencing with modern designs of time-discriminative over-current relays, emphasis is laid upon the importance of a definite minimum time characteristic and upon the correct methods of obtaining directional features. The special requirements of such relays when applied to give sensitive earth fault protection are indicated and means of obtaining a suitable polarising voltage are explained. A description of a sensitive earth fault relay of the wattmeter type is also given. It is also shown that as networks grow in size and as more linking up between systems takes place, it becomes more difficult to obtain satisfactory protection by over-current and directional time limit relays, and unless pilot wires or special cables are provided, dependable discrimination is practically impossible. This is due to two main causes—the possible variation of feeding points, and the greater number of sub-stations in series. To some extent the former difficulty can be overcome if the relay times are regraded whenever the feeding point is altered, but the elimination of the latter difficulty would necessitate longer minimum time delays than are practicable. The impedance relay, however, offers a solution to the problem, and within the last few years many such relays have been installed. The principle that governs the design of all impedance relays is that the relation between the fault current and the voltage at the point where the relay is connected will depend upon the impedance of the feeder or line between the point and the fault, or $Z=E/I$. Thus a relay having a current element the torque of which is opposed by the torque of a voltage element, could be so designed that it would only close its contacts if the ratio E/I were less than the impedance of the section of line or feeder to be protected. Such a relay would, therefore, only operate for faults in its own section, since with more distant faults the torque of the voltage element would overcome that of the current element, and produce a torque in the reverse direction. There is, however, a practical difficulty in applying such relays, as, owing to the variable resistance of the arc, it is impossible to estimate correctly the exact impedance of the feeder, with the result that the relay must be adjusted for an impedance greater than that represented by the latter. Successive relays will thus overlap each other and might operate for faults within a part of the next section, but this is overcome by introducing a time delay feature, which causes the operation of the relay to slow down as the distance between it and the feeder increases. A fault close to the relay would therefore cause quick operation to trip the circuit breaker before the slower acting and more distant relay could operate.

Descriptions are given in the paper of definite impedance relays and impedance time relays, and a simple and effective method is described which reduces the variable effect of the arc to negligible proportions. The compensation consists of an adjustable resistance connected in series with the current coil of the relay, and the potential drop across this resistance is applied to the restraining coil in such a direction that it opposes the resistance component of the impedance voltage. By adjusting the value of the resistance it is possible to compensate entirely for the resistance component of the impedance of the line or feeder, and, in addition, to reduce the error due to the maximum variation of the arc.

In the latter part of the paper the field of application of low-voltage relays is defined, and the method of their use is illustrated. Attention is then directed to the advantages of pilot wire feeder protection and the limiting features of the older forms are mentioned. Typical modern opposed voltage and circulating current methods which are giving satisfactory service on modern systems are described, and the new field of direct-current pilot wire protection is discussed. The main classifications of this type of gear are defined, and the paper concludes with a description of a novel and flexible method of protection for duplicate and multiple parallel feeders.

General Operation Experiences with the First "Wood" Steam Generator.*

By E. WATSON SMYTH, of Manchester.

Introduction.—It is proposed to record the actual experience obtained throughout the various stages of development and subsequent operation of the first radiant-heat boiler in this country, fired exclusively with pulverised fuel, comprising the plant known as the "Wood" steam generator. In modern industrial works the supply of power is a matter calling for the widest experience, for the costs of all manufactured articles must include their fair proportion of the power charges. Fortunately modern apparatus is available which renders possible the exact allocation of charges for water, steam, electric, and hydraulic power.

During the early part of 1924 the development of pulverised fuel firing became prominent, and in view of the possibilities of coal dust firing for metallurgical furnaces, progress both in England and on the Continent was closely watched. It was at this stage that the proposal was made to install the radiant-heat boiler now known as the "Wood" steam generator. On the assurance of the designer that violent fluctuations in steam demand would not adversely affect the operation of the plant, the final decision was made to proceed with the installation. The following account is intended to give details of every difficulty experienced from its first steam trials up to the present, and includes observations and conclusions arrived at during a period of 3500 boiler operating hours from March 15th, 1928, to December 31st, 1928.

The troubles encountered have required no very serious or radical changes in design, thus showing: (1) that the design of combustion chamber as originally installed in this unit is not likely to undergo any great modification in the near future; (2) that it is possible to evaporate 90,000 lb. of water per hour with only 1900 square feet of pressure heating surface, a condition which has never been adequately demonstrated before; (3) that it is definitely possible to propagate a flame with pulverised fuel in a combustion chamber composed entirely of steel water walls, without the addition of refractory materials—a fact of the utmost importance to the future development of boiler designing.

General Description of Combustion Steam Generator.

The sectional elevation, Fig. 3, gives a general view of the generator as originally installed. Construction was commenced during March, 1925, and completed during October, 1925.

Boiler Drums.—There are four solid forged drums, namely, the top steam drum, the top back drum, the front bottom drum, and the back bottom drum. The whole of the pressure heating surface is arranged to form the combustion chamber by means of four walls of "Murray" fin tubes. The two top drums are connected by nineteen 4in. tubes, whilst the two bottom drums are connected by fifty-six 4in. diameter tubes, generally known as the water screen.

Supporting Structure.—The structure for supporting the combustion chamber is simple and comprises four built-up steel columns, attached to which are the necessary gusset plates to form the cradles for holding the two top drums. Whilst cradles are formed in the two main columns for the two bottom drums, it should be noted that these are not actually used for this purpose, the top cradles taking all the weight in order to allow for expansion.

Casing.—The casing is constructed of light steel plate suitably reinforced with angles to house the insulating material behind the tubes. The four walls have 4½in. of fire-brick between the back of the tubes and the casing, together with 2in. of "celinsulate" for additional insulating purposes.

Combustion Chamber Roof.—The roof of the combustion chamber is formed by two thicknesses of fire-brick laid on top of the tubes, shaped to form a flat surface exposed to fire, as shown in Fig. 1. This prevents infiltration of air into the combustion chamber. The four corners of the combustion chamber are formed by vertical channel irons, thus making the chamber square with the corners taken off. Built into the flat corners is 9in. of fire-brick extending the full height of the chamber. This is necessitated by the arrangement of the pulverised coal burners.

Burners.—The burner pipes are introduced at all four corners of the combustion chamber by means of a cast iron box so arranged that the coal pipes are in the centre of a square box directly connected to the air ducts from the air preheater. This ensures the correct mixture of air and coal at the point of combustion. One of the most essential factors governing the rapid steam-raising properties of this type of boiler is that the flames from the coal burner pipes must scour the vertical tubes of the four walls. To accomplish this the burners are set tangentially to an imaginary circle 4ft. 6in. diameter, having its axis at the centre of the combustion chamber. The effect of this arrangement is effectively to scour the tubes with flame, and considerably to increase the length of the flame path, thus causing the products of combustion to remain in the chamber for a longer period of time. Under correct conditions these products are completely burned before passing out through the water screen.

Ash Settling Chamber.—This calls for no particular comment other than that it is constructed of ordinary fire-brick.

Superheater.—The superheater was of a somewhat special design and was manufactured in Manchester by the Marine and Locomotive Superheater Company. The saturated steam from the boiler entered the top headers. The superheated steam was led out of the bottom headers into a 10in. steam main running on the side of the boiler-house.

Air Preheaters.—Directly above the superheater casing is situated the air preheater. This is arranged in two banks forming a top and lower air preheater, so allowing the forced draught fan suction to be coupled directly to the top air heater and the fan discharge to the lower air heater. The gases from the combustion chamber are exhausted at the top of the air heater by means of an induced draught fan, through a suitable duct direct to the chimney. Both forced and induced draught fans are of the "Sirocco" type.

As laid down originally, the whole of the plant formed a complete self-contained unit including the raw coal bunker, pulverising equipment, pump house, and operating platform. No coal driers were installed, for it was on this installation that the system of drying with hot air in the mill circuit was first tested and established in practice. As the plant was installed experimentally until successful operation was established, a great deal of care was devoted to the control features. Remote electrical control and recording instruments for steam flow, pressures, and temperatures were all arranged on a central operating panel.

Performance on Steam Trials with Information as to Failures Experienced and their Causes.

Initial Operation, October, 1925.—At the end of August, 1925, the final water test had been carried out and the generator was in readiness for steaming. The auxiliary lighting equipment, consisting of four high-pressure oil burners, was put into operation on October 2nd, 1925. On October 9th four coal burners were brought into commission without difficulty, and a short test was carried out for three hours at an actual rate of 40,000 lb. of steam per hour. There followed a series of trials, each of which necessitated some minor modification, until on December 14th a six-hour trial was carried out. Very careful observations were taken, and a summary of the results obtained will be of interest as certain of the troubles which were encountered at a later period were evident during this run.

Boiler Duty.—During the first four hours of this test the average load on the generator was maintained at 48,000 lb. of steam per hour, actual evaporation. During the last two hours the load was gradually increased to 70,000 lb. of steam per hour, actual evaporation.

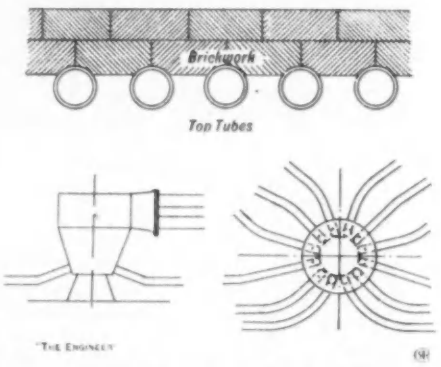
Coal Consumption.—The average coal consumption for the first four hours was 3900 lb. per hour, and for the last two hours 5120 lb. per hour.

Steam Temperatures.—The mean temperature of the superheated steam rose from 550 deg. Fah. at the start to 850 deg. maximum, the average temperature of the steam over the six-hour period being 800 deg. Fah.

Flue Gases.—The average temperature of the gases entering the air heater was 800 deg. Fah. The final gas temperature leaving the induced draught fan averaged 340 deg. Fah.

Preheated Air.—The average temperature of the preheated air during this test was 700 deg. Fah.

Efficiency.—The summary of this trial gave the following



FIGS. 1 AND 2—COMBUSTION CHAMBER ROOF AND CYCLONE DISTRIBUTOR

results, the coal as fed to the boiler having a calorific value of 13,300 B.Th.U. per pound:—

	Per cent.
Efficiency	89·5
Heat loss in flue gases	8·75
" " ash	0·5
" " radiation	0·5
" " moisture in coal	0·75
	100·00

Observations on Test.—It was observed during this trial and subsequently proved during a later test that with excessive CO_2 the combustion chamber was filled with hot gases which extended through the water screen tubes and caused a rise in superheat temperature with consequent high gas temperature in the air heater.

By varying the speed of the forced draught fan the CO_2 content of the gases could be regulated quite easily. During the trial it was endeavoured to maintain 14 per cent. of CO_2 in the gas samples taken just below the water screen. The readings obtained at the chimney base during the same period gave an average of 12½ per cent.

The fineness of the coal had an effect on the combustion conditions established during the test. Screen analyses were taken during the trial with the following results:—

	Through 100-mesh screen. Per cent.	Through 200-mesh screen. Per cent.	Moisture. Per cent.
1st sample	69·2	54·07	5·8
2nd sample	81·2	59·9	5·0
3rd sample	87·5	68·0	4·5
4th sample	90·05	69·2	5·0
5th sample	92·3	72·0	4·2
6th sample	94·1	75·1	3·8

With the coarser coal unsatisfactory combustion took place and particles of coal passed through the water screen incompletely burnt.

The final temperature of the steam was excessive and much too high for operating the plant installed in the works. Also the high temperature of the gas passing to the air heater endangered the plates of the lower air heater, although at the rates at which the generator was operating at this stage definite conclusions could not be formed.

First Modification.—As a result of the unburnt carbon in the ash which was noticed in this trial an interesting modification was made. As previously explained, the coal on entering the boiler is picked up by the stream of air from the forced draught fan and swirled round the four

* The Institution of Mechanical Engineers, January 24th.

walls of the combustion chamber. But as the coal burner pipes are situated some 12ft. above the water screen tubes it will be realised that the velocity of the gases as they sweep down the walls of the chamber is reduced. To prolong this swirling effect, and thus give the coal particles longer time to burn in the combustion chamber, four secondary air pipes were taken from the hot air ducts and admitted at the four corners of the combustion chamber, pointing in the same direction as the coal feeder pipes, that is, tangentially to an imaginary circle having for its axis the centre of the combustion chamber. This arrangement showed a marked improvement in subsequent tests.

General Conclusions.—(1) The temperature of the steam under all conditions of load was excessive. At certain loads this temperature exceeded 1000 deg. Fah.

(2) The air and gas temperatures were too high and liable to damage the ducts and air preheater.

(3) Apart from these features, the general design of the plant was satisfactory, and the unit was capable of generating 80,000 lb. of steam per hour as a normal load.

Second Modification.—Early in 1926 it was decided to modify the water screen with the object of absorbing the heat from the gases before passing them out of the combustion chamber. The fifty-six plain tubes were cut out and replaced by a similar number of tubes each having a series of discs or gills welded on. The discs were ¼in. thick and were spaced 2in. apart. This arrangement gave an increase of 1216 square feet in the heating surface of the water screen tubes. The maximum temperature of the gases directly under the water screen at peak loads was 1410 deg. Fah. At the peak-load period the gas temperatures on entering the air heater were still too high and averaged 925 deg. Fah. The high temperatures in the combustion chamber began to affect the discs or gills on the water screen tubes, and it became evident that these would ultimately burn away.

New Operating Difficulties.—During this series of tests the output of steam was invariably maintained at the full normal load. This enabled the system of feeding and distributing the coal to the burners to be effectively tested. It will be seen on referring to Fig. 2 that the method of distributing the coal to all twelve burners was by means of a cyclone distributor with twelve discharge ports arranged on the lower peripheral edge. These burners were each controlled by means of a butterfly valve fitted with a vertical spindle adjacent to the discharge ports. During the full-load tests it was observed that the maximum rate of evaporation could be obtained with eight burners. It was also noticed that when attempting to operate the butterfly valves in order to isolate the four surplus burners the distributor choked, due apparently to the pulverised coal filling up the short lengths of pipe between the distributor and the valve. The coal then commenced to accumulate inside the distributor and interfered with the operation of the remaining burners.

So great were these difficulties that it became necessary to replace the original distributor by two four-ported distributors arranged one above the other. This alteration has effectively overcome the difficulties experienced, and the new arrangement lends itself well to the method of operation now practised daily on this unit. It is now possible to run the plant by using the lower distributor and four top burners for all loads up to and including 40,000 lb. per hour, and the additional burners are operated through the lower distributor for all loads exceeding this figure.

The International Combustion Engineering Corporation, of New York, were kept fully informed of the results obtained, and they sent over Mr. Henry Kreisinger to conduct a complete and independent test on the generator. Mr. Kreisinger arrived in May, 1926, just after the commencement of the coal mining dispute. This was most unfortunate, but a supply of fuel was ultimately obtained and the boiler was prepared for test. Careful preparations were made by Mr. Kreisinger to ensure that the temperature readings were accurate, and the apparatus originally installed for coal and water measurement was calibrated for accuracy and accepted by him as being correct.

Further Observations.—Generally these tests were of a disappointing nature. On account of the poor nature of the coal available, which caused excessive "bird-nesting" in the water screen tubes, the draught was greatly impeded. Further, as the plant had been closed down for a considerable time due to the coal shortage, the ash settling chamber had absorbed an excessive amount of moisture which had to be dried out before reliable results could be obtained.

A test at a high rate of evaporation was maintained for ten hours. It became evident that the trouble experienced from excessive superheat temperatures had not been remedied by the special discs on the water screen tubes, and it was also noticed that the calorimeters fitted to the two saturated steam pipes 2ft. above the discharge saddles on the steam drum showed distinct signs of priming, which were confirmed by the fluctuating temperatures measured in both headers of the superheater.

In his report Mr. Kreisinger made the following observations:—"Wet ground is a good heat conductor, and has high heat capacity. The heat loss to the ground is indicated by the high unaccounted for losses, which were very marked in the first series of tests. With a dry setting and when the plant is operating smoothly a generator with this amount of heating surface should give an overall efficiency of 81 per cent. without difficulty. It appears that the furnace of the steam generator is capable of burning powdered coal at much higher rates than is possible in the standard Lopulco furnace. With proper furnace operation this furnace should be able to generate heat at 40,000 B.Th.U. to 50,000 B.Th.U. per cubic foot of combustion space per hour, with incomplete combustion losses not exceeding 2 per cent." Mr. Kreisinger completed his report with the remark that "on the whole the results of the tests are encouraging."

The results of these tests are shown graphically in Appendix II.

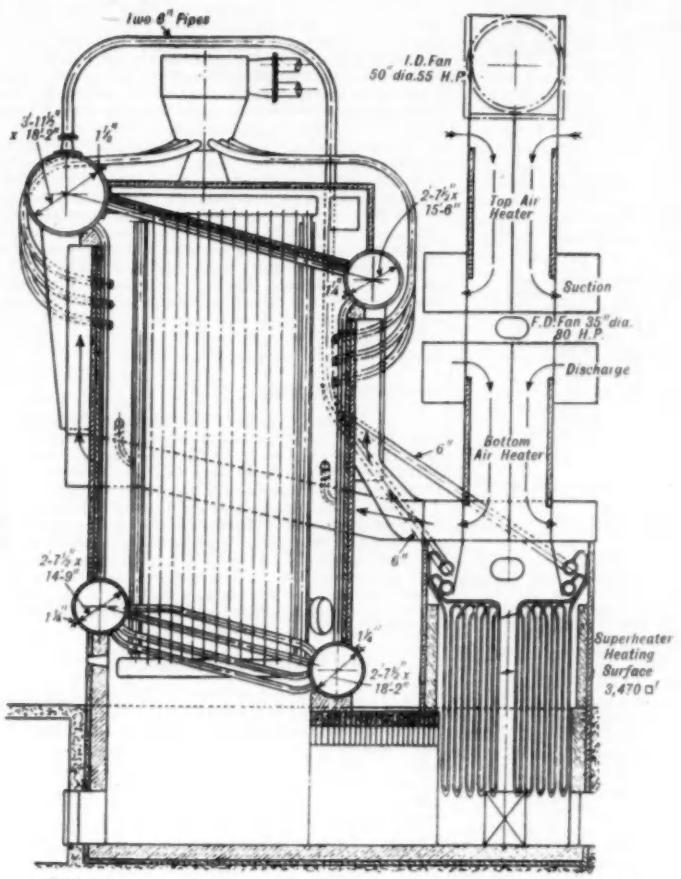


FIG. 3—ORIGINAL "WOOD" STEAM GENERATOR

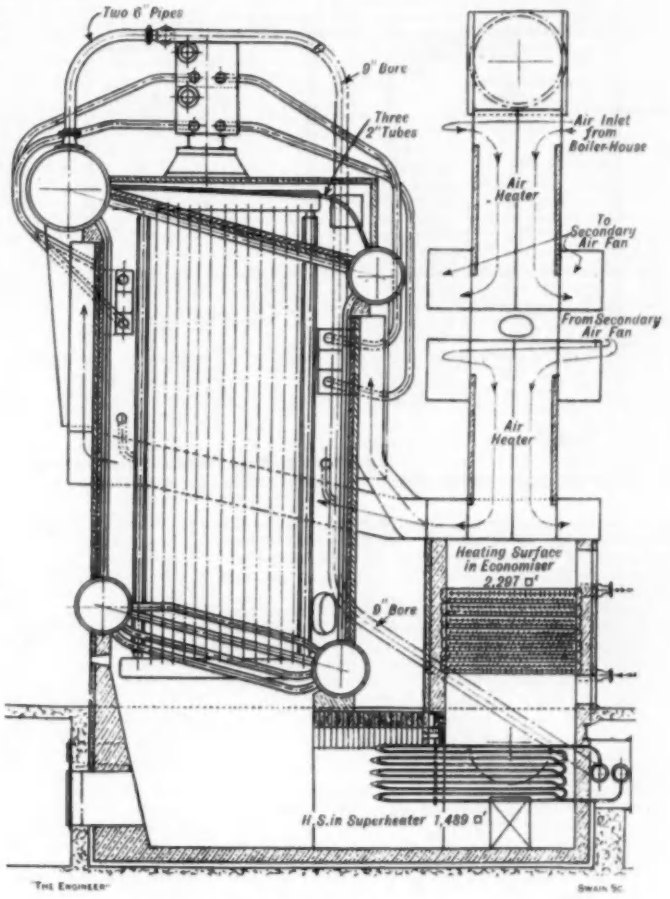


FIG. 4—NEW ARRANGEMENT OF GENERATOR

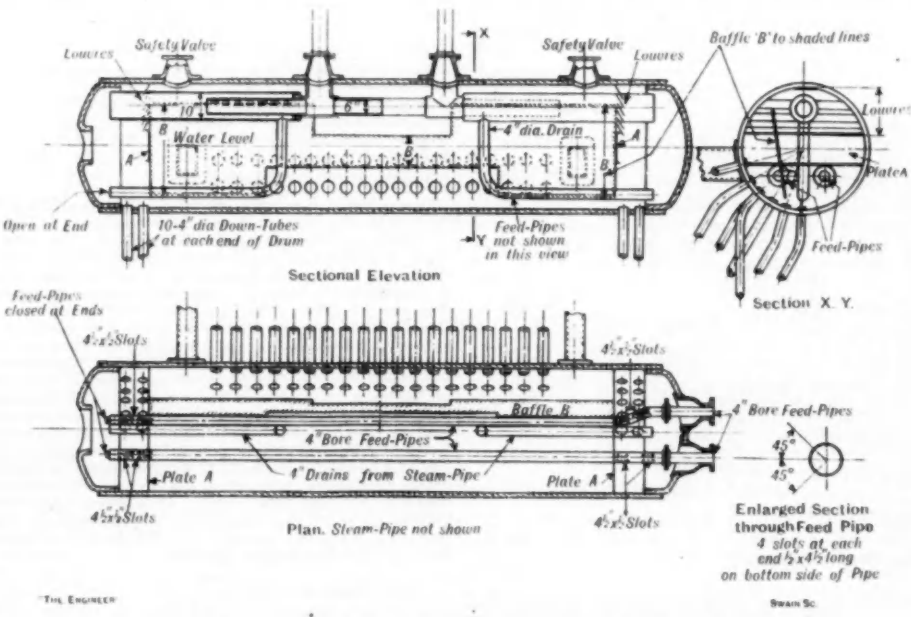
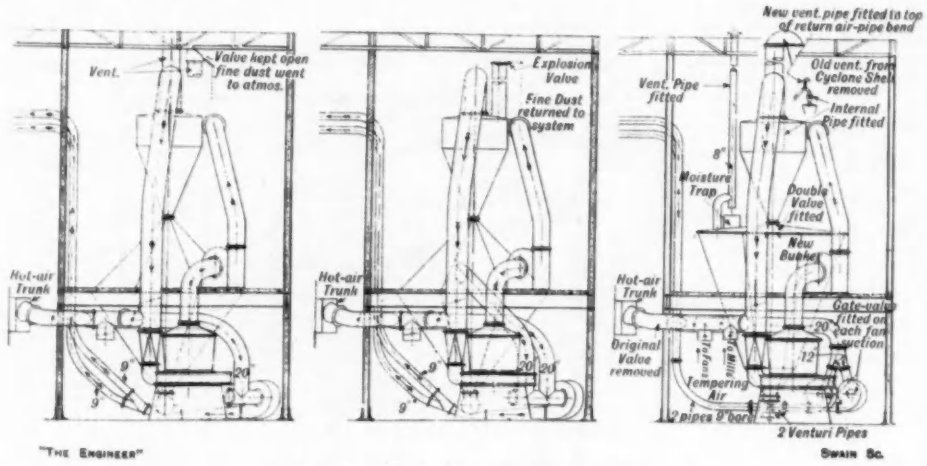


FIG. 5—ARRANGEMENT OF INTERNAL FITTINGS OF STEAM DRUM

Subsequent Modifications.—In spite of the difficulties attending this series of tests there was sufficient evidence to show that drastic alterations were necessary to overcome the difficulties occasioned by the high steam, gas, and air temperatures, and the more recent difficulties of priming.

Priming received first consideration, and in this connection reference should be made to Fig. 5. The steam drum as originally designed had a baffle plate B slightly



FIGS. 6 TO 8—PULVERISED FUEL PLANT.
AS ORIGINALLY INSTALLED. WITH PRIMARY AIR FAN. SUBSEQUENT ARRANGEMENT.

offset from the centre of the drum and set at an angle to the centre line. There were also two internal feed pipes running the full length of the drum, but with open ends. Each of these pipes had a slot 4½in. by ½in. at the feed check end of the drum.

The modifications made were as follows:—The existing 6in. diameter sparge pipe was extended to the end of the drum and increased in diameter to 10in.; two 4in. diameter drain pipes with open ends were fitted; end baffle plates with louvres extending just below the ends of the enlarged sparge pipe at each end of the drum were fitted; the

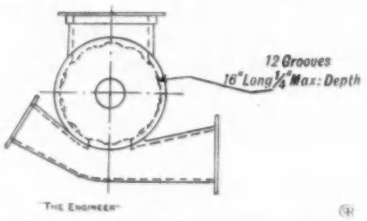


FIG. 9—PULVERISED FUEL FEEDER.

existing internal feed pipes were closed at their extremities and slots made so that the water would only enter at the ends of the drum directly over the ten down tubes.

These modifications appeared somewhat elaborate, but as it was desired ultimately to use the unit in commercial service on a widely fluctuating load it was necessary that every precaution should be exercised. It was also decided to replace the gilled water screen tubes with plain tubes as originally fitted, and this work was completed and the unit again under test on July 16th, 1926. This test proved that the modifications were satisfactory and enabled another set of observations to be made. The throttling calorimeter observations are recorded in Appendix III. to show to what extent the priming trouble had been overcome.

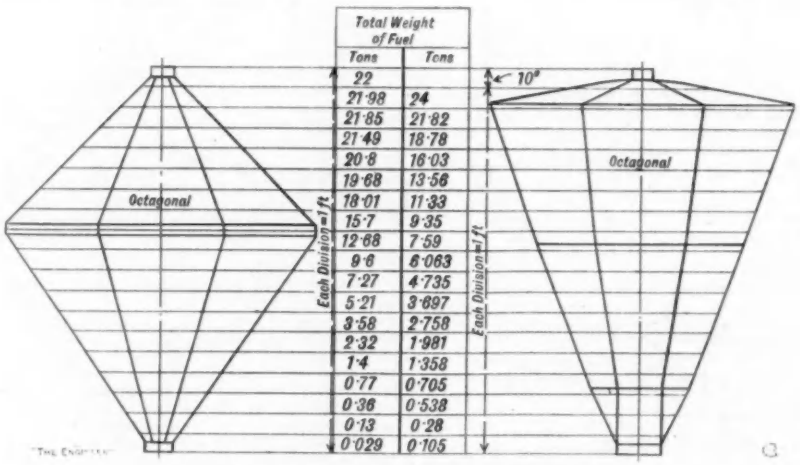
Further Reconstruction.—Further important modifications were, however, decided upon, namely: (1) to reduce the heating surface of the superheater from 3470 square feet to 1489 square feet; and (2) to introduce an economiser between the superheater and the air preheater with a heating surface of 2297 square feet, thus slightly increasing the convection surface after the combustion chamber.

Fig. 4 shows the new general arrangement of the generator with the leading particulars of the revisions made at this period, which necessitated the complete closing down of the unit until the close of the year. A further slight alteration was made at the same time by inserting three 2in. tubes connecting the back and front steam drums. On examining the top back drum it had been evident that steam had accumlated in the upper portion above the cross tubes. To allow this steam free access to the front steam drum these additional tubes were fitted above the brick lining covering the top tubes, and thus remote from the flame of the combustion chamber, as shown in Fig. 4.

Improvements were also made in the ash-settling chamber, the coal feeders and the pulverised coal bunkers, which are described below.

Ash-settling Chamber.—The original ash-settling chamber was built with vertical walls on the front and sides. It was believed that the gases as they passed through the water screen tubes were inclined to be stagnant at the front wall, their tendency being to take a natural sweep towards the superheater. It was therefore decided to incline the front wall under the combustion chamber, and this was accomplished by building a tapered wall of firebrick, which reduced the original capacity of this chamber from 1778 cubic feet to 1450 cubic feet.

Coal Feeders.—Fig. 6 shows a general arrangement of the pulverised fuel plant as originally installed. It is not proposed to record here all the troubles experienced before this section of the plant was completely satisfactory, though there were faults in the design which to some extent delayed the correction of the main troubles on the generator. Reference is made here, however, to the operation of the mechanism for feeding the pulverised coal to the combustion chamber. The original feeder was of the drum type, and as fitted on this installation was of an original design that had not previously been tested in practice. Fig. 7 shows the arrangement of the feeder with the primary air fan, and the design of the feeder is shown in Fig. 9. It consisted of an outer casing arranged to take a drum 1ft. 9in. diameter, having twelve grooves parallel with its axis, each groove being 16in. long with a maximum depth of ¼in. Its speed could be varied from 4 revolutions per minute to 16 revolutions per minute. It possessed several satisfactory features, such as low power consumption, freedom from flooding, and the ability to deal with moist pulverised fuel. On the other hand, it was found in practice that it had a distinct tendency to cause "panting," which was more marked when operating at the slower speeds. A new drum was therefore designed with the slots arranged spirally instead of parallel with the axis. This made it possible to deliver a more constant stream of coal and mitigated the "panting."



FIGS. 10 AND 11.—PULVERISED FUEL BUNKERS.

Pulverised Coal Bunkers.—Another quite frequent difficulty was the suspension of pulverised coal in the original bunker, the design of which is shown in Fig. 10. This design was superseded by an entirely new one, shown in Fig. 11, which had much steeper sides. The capacity of both bunkers was about 22 tons. Subsequently the new type of feeder known as the Rosencrants was installed, and Fig. 8 shows a general arrangement of the pulverised coal bunkers, coal feeders, and primary air plant.

(To be continued.)

Canadian Engineering News.

(From our own Correspondent.)

A Long Canal Lock.

HERALDING the near completion of the great Welland Ship Canal, which has been under construction since 1913, Lock No. 8 went into operation recently, when the ss. "Meaford," of the Canada Steamship Lines, broke a silken cord stretched across the lock and passed through down-bound from Lake Erie to Lake Ontario. The opening of the guard lock brought into operation another stretch of the new canal from Port Colborne to Ramey's Bend. The descent of the Niagara escarpment will, however, continue to be through the locks of the old canal, the new canal being scheduled to come into operation in 1930. Lock No. 8 is that which controls the level of water in the canal from Port Colborne to the top of the escarpment at Thorold, where the seven lift locks stretching from there to Port Weller overcome the difference of 325½ft. between Lakes Erie and Ontario. This lock has a length of 1380ft. and a width of 80ft. It is at least 25ft. longer than the biggest lock at Sault Ste. Marie, and exceeds in length the largest in the Panama Canal. It can accommodate the two longest vessels plying at the present time on the Great Lakes. Locks Nos. 1, 2 and 3 at the Port Weller end of the canal will be ready for ships at the opening of navigation this year, and the remaining four locks, Nos. 4, 5, 6 and 7 will be completed and opened progressively during the early summer.

Fertiliser Industry.

Manufacture and distribution of fertilisers on a large scale from new factories at Hamilton, Ontario, and Beloeil, Quebec, as well as from the present factory of the Triangle Chemical Company in British Columbia, will be started soon, it is announced by Canadian Industries, Ltd. This decision follows an exhaustive survey and study of the fertiliser market in Canada. According to this scheme, the factories will turn out superphosphate and fertilising mixtures adopted to soil and crop conditions in the respective provinces, and in this venture, as with its others, Canadian Industries, Ltd., will, it is said, have the technical and commercial backing of Imperial Chemical Industries, Ltd., of Great Britain.

United Kingdom Coal Imports.

Imports of Scotch and Welsh anthracite coal into Canada are increasing rapidly. October was the biggest month of the 1929 season, with shipments totalling 84,824 tons, which definitely sets last year's figures over those representing the whole amount of British anthracite discharged at the Port of Montreal in 1928. The total stood at 435,916 tons, which was 76,000 tons in excess of imports up to the end of 1928.

New Water Supply for Calgary, Alberta.

The Calgary City Council is considering the expenditure of 3,770,000 dollars on the construction of a new reservoir five-eighths of a mile south of the city limits, a new filtration plant at the pumping station, new supply and distribution mains and other improvements, the source of supply chosen being the Elbow River. The scheme selected is the cheapest of eleven projects which have been under consideration, and construction, if approved, will extend over a period of two and a-half years, after which a sufficient supply of filtrated water will be available for a city of 200,000 people. The present supply of water is taken from the Bow River west of and above the city. The proposed new supply from the Elbow River will necessitate the building of a dam 60ft. high and 800ft. long on the crest, creating a proposed reservoir with a surface area of 900 acres and impounding 3,600,000,000 gallons of water. The principal item in the estimated cost of the new water system are:—Chinook reservoir, 850,000 dollars; water purification plant, 915,000 dollars; main pumping station at Chinook reservoir, 270,000 dollars; two 36in. pipe lines to link up with existing distribution mains, 970,000 dollars; new distribution mains throughout the city, 460,000 dollars; land, right of way, &c., 150,000 dollars.

Ontario Air Forest Patrol.

The Ontario Provincial Air Service during the past season flew approximately 850,000 air miles, or about 11,500 flying hours, starting on May 1st last. The season's work constituted a record in the history of the service, 5400 more flying hours having been achieved than in 1928. A remarkable feature of the season's operations was the fact that the record was achieved without injury to a single member of the *personnel* or to a single passenger, in spite of the fact that flying took place during one of the worst fire hazard years in the history of the Department of Lands and Forests. The Forest Patrol covers the vast area of Northern Ontario from Lake Superior to James Bay, and was able to perform many valuable services in connection with bringing help to stranded expeditions and in conveying injured or sick persons from outlying trading posts to hospital. Most of the aeroplanes are now at the Sault Ste. Marie base for refitting and overhauling in readiness for the 1930 season. Only two of the many stations from which the aviators battled with the bush fires this exceptional season remain open at present—those at Fort Frances and Kenora.

New Vancouver Pier.

To provide adequate facilities for berthing their three new coastal passenger steamers at Vancouver, the Canadian National Steamships Company proposes completely to remodel and extend its existing pier at the foot of Main-street, at an expenditure of approximately 750,000 dollars. According to present plans, the new pier will be 1500ft. in length and have a width of 220ft. It will extend to within 200ft. of the headline established by the Vancouver Harbour Commissioners. Besides affording accommodation for four coastal steamers, two on either side, the pier will have a berth at its extremity for one small vessel, and there will be a berth of 150ft. at the shore end for oil lighters and other small craft. Approach to the

pier from the foot of Main-street will be made over a wide viaduct, erected on heavy piling, and through an imposing archway. Passenger ramps are to be provided for communication with each steamship berth, and facilities for rapid handling of baggage and goods will be incorporated in the structure. Water and oil mains will connect with each steamship berth, and a large number of hydrants will be supplemented by the installation of a complete sprinkler system throughout the offices and warehouses for protection against fire.

Large Dam on Mattawin River.

Excavations for a large dam on the Mattawin River, at Toro Rapids, near St. Michel des Saints, Quebec, will soon be begun by the Shawinigan Engineering Company, subsidiary of the Shawinigan Water and Power Company. The object of building the dam is to regulate the water so that a greater minimum flow may be made available for the power works further down the river. The dam itself will be about 2400ft. long and will include an earth section 1830ft. in length having reinforced concrete walls at the channel, and a concrete section 570ft. long. This concrete section will include regulating sluices, discharge sluices, and a small hydro-electric unit for the operation of the dam. The water level at the dam site will be raised about 65ft. and a considerable area of territory will be flooded. It is estimated that the volume of water impounded will be 36,000,000,000 cubic feet, or over 224,000,000,000 gallons. The estimated cost of the project is 2,300,000 dollars.

New Steam-electric Plant.

The Dominion Coal Company, a constituent company of the British Empire Steel Corporation, has decided to build a steam-electric power station on tide water at Glace Bay, Nova Scotia. The plant will be the largest steam-electric station in Eastern Nova Scotia. It will utilise pulverised coal from the company's mines, and with high-pressure boilers and steam turbines it is intended that it shall operate at the highest efficiency possible under present steam power station practice. The boilers are to operate at 450 lb. steam pressure.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Conditions Unchanged.

DEMAND for iron and steel continues unusually quiet, and in most branches of industry in the Midlands and Staffordshire works are carrying on chiefly by reason of orders previously booked. Considerations which have retarded the buying of iron and steel this month have lost none of their power. Consumption is at a lower level than in the later months of last year, and the outlook remains obscure. Though the indications are that stocks of raw material are low, users are deferring the arrangement of contracts on a scale which a month or two ago would have been considered very unwise. The reason is that the demand for finished products has fallen off, thus changing the outlook. The heavy engineering trades, the electrical industry, and the general engineering section in this area are for the most part dull, although several of the firms engaged report an improvement in the general situation. This improvement, however, is patchy, and cannot be regarded as an indication of an all-round advance. After a temporary easing of foreign competition, local iron and steel masters have now to contend with more formidable rivalry.

Blast-furnacemen Less Confident.

The continued abstention from buying on the part of foundrymen, the quieter conditions ruling, and the easement in the fuel situation, have of recent weeks brought about such a change in the raw iron industry that Midland blast-furnacemen, though still in a strong position, are less confident than they have been for many months. In some circles on 'Change in Birmingham this week it was claimed that the initiative is no longer with the blast-furnacemen. Smelters are not prepared to admit it, however. Some Derbyshire and Northamptonshire firms which were recently asking premiums are now prepared to accept business at the minimum selling figure fixed by the Association. All pig iron makers are strongly opposing anything in the nature of market degeneration. Since this time last year they have formed a strong organisation, and this should now assist them favourably. It is, however, now considered very unlikely—in view of the changed conditions—that prices will be advanced at the meeting of the Producers' Association this week. In all probability the quotations of £3 18s. 6d. for Derbyshire No. 3 foundry and £3 15s. for Northamptonshire will be reaffirmed. At date foundrymen and millmen are buying from hand to mouth, and smelters find no pressure for deliveries. Furnaces are well sold forward, and are receiving a good aggregate of small tonnage business from day to day. Consumers are not entering into new forward commitments. There is no amendment of the unsatisfactory situation in the forge iron department. Little interest is taken in this material, Black Country forgemen's requirements being small. Values are, as laid down by the producers' organisation, 4s. per ton below No. 3 foundry iron prices. Blast-furnace coke is now easier to obtain, and values have fallen about 1s. per ton from where they stood at the turn of the year. The price is still considered high, sufficiently so, smelters assert, to justify an increase in selling prices of pig iron. Raw iron consumers, on the other hand, are looking for an early fall in prices of forge and foundry grades of iron.

Steelmasters Need Orders.

Mills in this district producing heavy steel have some reserve of work on the books for execution, but new orders are badly needed. Users seem no more inclined than they were at the opening of the quarter to place orders. Engineers consider the outlook too obscure to justify the anticipation of future requirements. Indeed, such is the state of trade in many branches that ironmasters report specifications for delivery against existing contracts to be disappointing. Endeavours to improve upon this latter state of affairs have met with little success. The constructional work in progress in the Midlands is mostly on the small side, as are the new contracts coming on to the market. Competition for them is very keen, and the profit margin, to those securing the work, is small. Heavy steel is unchanged at £8 7s. 6d. for angles, £8 10s. for joists, and £8 17s. 6d. for ship, bridge and tank plates. Prices of uncontrolled steel are less firm. Makers who recently wanted fully £8 2s. 6d. for small bars are now prepared, under pressure, to make a concession of half a crown. This price is not acceptable to all millowners, but most of them, it is reported, are prepared to concede something from the £8 2s. 6d. figure formally considered the minimum. Native billets are procurable at £6 2s. 6d. and sheet bars at from £5 18s. 6d. to £6 2s. 6d. Makers find some difficulty in securing business against the foreigner, who quotes £6 6s. 6d. for small bars and £5 10s. to £5 11s. for billets. All the efforts made to control continental prices of half-products cannot cloak the instability which has overtaken the market. There was a fair demand on the Birmingham market this week for steel strip, which made upward of £8 2s. 6d. per ton.

Staffordshire Finished Iron.

In the Staffordshire finished iron industry there is a good deal of idle plant, though marked bar makers find a fairly steady demand. This high-class material is in regular call for exacting engineering purposes, and makers maintain their quotation at £12 10s. per ton. Ironmasters in this branch keep a cheery spirit for, although most departments of the iron and steel trade have shown some falling away this quarter, business in marked bars has been maintained at the moderately satisfactory level which ruled throughout the latter part of last year. Moreover, indications as to the future trend of business are held to be assuring. There is no improvement of note in the Crown bar department. This quality iron is quoted £10 to £10 10s., according to grade. Makers in other districts, who compete in this market ask a lower price for their output, consequently a large number of orders for Crown iron go out of this district. Much more work would have to be done at Staffordshire mills before it could be claimed that active conditions rule. Makers of nut and bolt iron find their position, in the competition for business, made worse by the recent fall of 3s. to 4s. per ton in Belgian No. 3 bars. Their selling figure of £9 upwards is relatively so high as to make their chances of securing orders almost infinitesimal. Whatever difference there may be in quality it is not sufficient to bridge the difference in prices. Black Country works are for the most part using either steel or continental bar iron for the production of bolts, nuts, and fencing. Producers of wrought iron strip are well employed, but business is not so brisk as it was. Mills are not in urgent need of orders, and adhere to the selling figure of £11 2s. 6d. per ton.

Galvanised Sheets.

A further fall in values of galvanised sheets has brought them to a level at which consumers consider it advisable to do business, even though they may only be putting them into stock. Mills urgently in need of work have been offering supplies of 24 gauge corrugateds at £11 15s. and £11 17s. 6d., and a number of foreign buyers, notably in South America and the West Indies, have placed business at this very low figure. Many millowners, including some in this district, refuse to compete for business on the basis now ruling, and have practically withdrawn from the market. It is anticipated that as soon as business gets into anything like a swing, sheet prices will be advanced. It is with this in view that some mills are "hanging off" the market. Merchants and consumers at home have this week bought in a small way as a speculation.

Rolling Stock Contracts.

Midland firms have just secured some good and welcome orders. The Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., is to supply to the L.N.E.R. thirty 25-ton four-wheeled hopper ballast wagons and four ballast plough vans, and to the L.M.S.R. forty steel bodies and underframes for bogie corridor third-class carriages. Contracts have also been placed with the same firm for 150 all-steel ventilated covered goods wagons, each of 50 tons capacity, for the Buenos Aires and Pacific Railway, and for forty all-steel bogie hopper wagons for transport of stone ballast on the San Paulo (Brazilian) Railway. The Sentinel Waggon Works, Ltd., of Shrewsbury, is to supply the Belgian National Railways with three 100 H.P. gear-driven Sentinel-Cammell steam rail cars and the Western Australian Government Railways with a standard type 100 H.P. gear-driven Sentinel-Cammell rail car.

Birmingham Blades for the Army.

The Birmingham firm of W. J. Wright and Co., Ltd., is this week being congratulated upon its success in securing the whole of the contract for supplying the British Army with razors and razor blades. The fact that it was secured against world competition, and that it was previously held by an American firm, speaks well for the Birmingham-made article.

Electrical Consumption in Birmingham.

Demand for electrical energy in Birmingham continues to increase. The sales during the December quarter showed an advance of 10,000,000 units, being 11¼ per cent. higher than in the corresponding period of 1928. The monthly progress report showed that during December 1200 new consumers were connected up, adding 10,300 lamps in the lighting section and 4050 H.P. in the power section. The total quantity of power now operative from the Corporation mains exceeds 330,000 H.P.

Coventry Engineering.

The position in the engineering shops in Coventry at the moment is regarded with some satisfaction, especially when it is compared with that existing in many industrial centres. The open weather is favourable to Coventry's main industry—automobile engineering—and good progress is being made with the large programmes upon which firms have embarked.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Conditions in 1929.

THE Engineering and Metals Section of the Manchester Chamber of Commerce, of which Alderman F. J. West has been elected chairman in succession to Sir Benjamin Longbottom, reviews the past year's experience in the engineering and allied trades in its annual report. Electrical engineering has, it is pointed out, again been the most active branch, and statistics show a new high record in export trade. Important contracts have been obtained from Holland, Hungary, Greece and Spain, as well as from a number of other markets which for some time had been regarded as closed. A greater volume of business has also been forthcoming from South American countries. Both in home and export business the competitive strength of the electrical engineering industry, especially in heavy generating plant and equipment, shows a great advance. Increased activity in the industrial and domestic groups is confidently anticipated when the full effects have been felt of the more aggressive selling policy which has been adopted by electricity supply undertakings.

A Patchy Year for Foundries.

Patchy conditions have been experienced in the foundry industry, and business in heavy castings has been somewhat disappointing. Foundries laid out for the production of light castings have, however, had busy periods and their prospects are considered to be promising. Further stabilisation of prices and the undoubted superiority of the British casting have made it possible for a good deal of trade which had been captured by the Continent to be brought back to this country. The report of the Section expresses the view that it is too early at this stage to expect the substance of the effects of the application of rationalisation to the heavy iron and steel industry, although there is distinct evidence of the latter's inherent recuperative power. Locomotive builders have been concerned at the amount of business offered by India which they have failed to secure in competition with continental firms, but in other markets they have obtained a better share for this country. The point is stressed that the past year saw the complete, or partial defeat of various artificial and uneconomic measures designed to maintain copper, tin and spelter prices at high levels. The immediate result must be greatly to the benefit of the whole engineering trade.

A Problem in Transport.

History in transport by road was made on Monday of this week when a locomotive weighing about 80 tons was conveyed from the works of the Vulcan Foundry Company, Ltd., Newton-le-Willows, *viâ* Warrington to Liverpool docks for shipment to India. The task was carried out by the Marston Road Services Company, of Liverpool and Manchester, a special vehicle, built by Scammell Lorries, Ltd., Watford, and designed to carry up to 100 tons by road, being employed. The locomotive in question is of the 4–6–2 type, and is the first of a consignment of fourteen for the Indian State Railways to be shipped in February, the order being for a total of thirty-nine.

Dock Improvement Schemes.

Altogether about £2,000,000 is involved in dock improvement schemes at Liverpool and Birkenhead which are contemplated by the Mersey Docks and Harbour Board, and plans for which have been submitted to the Government for sanction. The plans provide for the construction at Birkenhead of a new dock alongside the old east float to accommodate big vessels, and at Liverpool for the abolition of the Trafalgar Dock, the enlargement of the passages leading to the West Waterloo and Salisbury Docks, and the construction of new quays, bridges and passages, so as to effect substantial improvements at the Clarence half-tide dock. If the improvement programme outlined above is sanctioned it is expected to provide several years' employment for a large number of people.

Wirral Railway Electrification.

It is reported that the London, Midland and Scottish Railway Company intends to proceed at an early date with the electrification of the Wirral Railway, which serves the Cheshire peninsula lying between the river Mersey and the river Dee.

A Rayon Works for Preston.

A step towards the erection of a new works which is expected to employ about 3000 people has been taken by Courtaulds, Ltd., which have taken up options on about 200 acres of land at Ribbleton, near Preston.

Non-ferrous Metals.

Copper has lost ground slightly compared with a week ago, but all other sections of the non-ferrous metals market during the past week have experienced steady to firm conditions, with, in the case of tin and spelter, some measure of improvement in values to be recorded. In the market for standard brands of copper the week's turnover has been on a relatively small scale, and it is evident that both here and also in respect of

refined descriptions of the metal there is a continued tendency on the part of buyers to go slow. The plan of producers to restrict output still further may, of course, exercise eventually a "bullish" influence on the market, but for the time being, at all events, users seem willing to take a chance. A fair amount of interest has been shown in the tin section, particularly in respect of forward positions, and for the first time since about the middle of December, prices have registered an improvement, current values, which represent an advance on the week to the extent of about £4 a ton, being back to where they were at the beginning of January. There has been a rise of several shillings a ton in the case of spelter which, however, continues to hover round the £20 mark. Stocks of spelter are still largely in excess of the demand, and until there is a radical change in the position low prices may be expected to rule. Lead has been the subject of a moderate demand, but quotations have been maintained, and for the fourth successive week there is no alteration on balance to report.

Iron and Steel.

For the most part quiet conditions have ruled in the iron and steel markets here. Forward buying in the case of foundry iron has eased off appreciably, though the explanation of this lies largely in the fact that most users are now well booked. So far as can be seen, there has been no important contraction in the rate at which iron is going into consumption at foundries in this district. Prices are steady at 77s. per ton for both Staffordshire and Derbyshire No. 3, about 95s. for Scottish, and 92s. for hematite, all for delivery equal to Manchester. Bar iron is decidedly quiet, with Lancashire Crown bars quoted at £10 15s. and seconds at £9 15s. There has been a certain amount of new business in boiler plates for the locomotive industry, and most firms are taking fair quantities of these against contracts. General plates, however, are quiet, as are also most varieties of bars, including small bright-drawing qualities, which, up to the end of last year, had for some time been selling satisfactorily. The aggregate tonnage of constructional steel, which is being specified for on this market, continues to be the subject of complaint among rollers, a number of firms in this branch locally being short of work. There has been virtually no change in the price position either of home-produced materials or in continental, and the demand for the latter remains exceedingly slow.

BARROW-IN-FURNESS.

Hematite.

The market is steady and makers are well fixed for some months, for there has been no hesitation on the part of buyers to cover their requirements well ahead. Apart from the ordinary trade, the local demand for iron by the steel departments is maintained. Foreign business continues and several shipments to the Continent are due. There will also be some dispatches of pig iron for America. In better qualities of iron of special analysis the business continues to be steady, and in the case of this iron prices are from 2s 6d. to 5s. higher than ordinary mixed Bessemer numbers. The iron ore trade is steady. Better qualities of native ore are a little cheaper, while prices for Spanish ore are also down. Business in the latter is about the same as it was last week. The steel market is not brisk, but the works are kept going and are likely to be for a period with present contracts. A cargo of 7000 tons of rails for South America is shortly due away from Barrow. The hoop works continue their output, mostly on overseas account. East Coast coke is a little easier.

SHEFFIELD.

(From our own Correspondent.)

The General Position.

THE condition of depression in the local steel trade, or, at any rate, in most of its branches, with which the year opened, is still unrelieved. The exceptionally large number of hands who were suspended for the Christmas holidays are beginning to go back, about 1200 short-timers who were on the relief list having now resumed full time, but the unemployment returns are still abnormally heavy. Taken as a whole, the position of local trade is considerably worse than it was twelve months ago. The section producing basic steel is fairly well employed, but the demand for acid steel keeps very poor, and, out of a total of some eighty-two open-hearth furnaces in the area, only about forty are in operation. It is difficult to obtain sufficient orders to keep even this small number at work. There is a great scarcity, alike of forward work and of inquiries for anything like bulk quantities. A rather better condition is reported in the railway steel departments, but the demands made upon them are much below their capacity. A good tone is maintained in the special departments. Stainless steel is in ever-increasing request; the outlets for cold-wrought steel and strip grow more and more numerous; and the automobile, aircraft, and electrical industries continue to make large demands upon the city.

Tool Steels and Tools.

The position of the alloy steel and tool steel branches is unsatisfactory. Foreign competition has developed to a formidable extent, and it is difficult to find more than a few local firms which have even a moderate amount of work on hand. The file trade has started the year only moderately, but some of the tool branches report that bookings are better than in the last three months of the Old Year. The demand for farm and garden tools shows an improvement. There are expectations of the early receipt of a big batch of Russian orders for steel and tools. No definite information on this head is available at present, but it is known that Russia is urgently in need of large supplies of Sheffield goods. The way is now open for a resumption of trade with that market, which was so valuable before the war, and the export credit scheme should benefit local firms.

The Penistone Closing.

Efforts have been made by the local authorities of Penistone and district, but without success, to induce the directors of the English Steel Corporation to alter their decision to close the Penistone iron and steel works of the Cammell Laird branch. A deputation, representing the Urban District Councils of Penistone, Thurlstone, and Hoylandswaine, saw the directors at Sheffield last week-end, but only received confirmation of the firm's intention. They discussed the position from every angle, including local rates and railway rates, but were informed that the question of closing the works had been under consideration for some time, and that the directors could not alter their decision. The question of the future of the works property was raised, and the directors said that they would not stand in the way of the works being acquired by any other manufacturer; that they would consider any proposal of the kind, and would assist it as far as they possibly could.

More Rationalisation.

It has been officially announced that the old-established firm of Clayton and Shuttleworth, Ltd., manufacturers of heavy agricultural machinery, Lincoln, has been purchased by Marshall, Sons and Co., Ltd., general engineers, of Gainsborough. It is understood that the purchase is in connection with a scheme of rationalisation which is being carried out at the Gainsborough works. The matter was referred to at a dinner of the Gainsborough Chamber of Trade by Mr. A. Colegate, of Marshall, Sons and Co., who said that he was a believer in rationalisation, but that he could not yet divulge the direct results of the new arrangement.

Colliery Matters.

Development work at the new Upton colliery, in the Doncaster area, which was resumed recently, has not had to be continued long without producing satisfactory results. The No. 2 shaft has now been taken to a depth of 712 yards, at which the Barnsley seam was tapped. It was found to have the remarkable thickness of 9¼ft., and is stated to be of excellent quality. Cages are being installed, a heading driven between the two shafts, and rapid progress made with the erection of the surface plant. Men will be set on as the pit develops, and it is probable that in about three years there will be 4000 employees and a weekly output of 35,000 tons. The colliery will be one of the largest and most modern in the country. Figures almost as good as those which it is hoped to reach at Upton have just been attained at the Silverwood Pit of the Dalton Main Collieries, near Rotherham. During the week ending January 15th, 30,427 tons of coal were brought to the surface, of which 24,364 tons were wound up the West shaft. This feat was accomplished in the ordinary working time of eleven shifts. There were several short losses of time during the week, one stop being for fully an hour. Despite short-time working, over 1,332,500 tons were drawn at Silverwood last year, which was over 100,000 tons in excess of any other year. The West Pit is now being further developed, and coal-getting machinery is to be introduced which will greatly increase the output in the near future. It is likely that before long the colliery will reach an annual output of 1,500,000 tons. About 4000 men and boys are employed.

A Large Rolling Mill.

Sheffield is now engaged on the construction of a rolling mill which will be the biggest producing unit of its description in the world. It is being built by Davy Bros., Ltd., for the Newport works of the Whitehead Iron and Steel Company. It is laid out for the production of a large variety of semi-finished and finished products, including sheet bar, general merchant sections, and rods down to No. 2 gauge. One of the 700 H.P. drives is for a roughing mill, the 1500 H.P. drive is for intermediate mills, and the other four 700 H.P. drives are for finishing stands. The control of the motors will be centralised at a control desk, so placed that it commands a full view of the whole mill. The orders for the electrical equipment of the mill, and for some of the other principal plant at the Newport works, have been placed with the Metropolitan-Vickers Electrical Company.

To Carry On.

The debenture stock holders of the Midland Iron Company, Ltd., Rotherham, who recently appointed a receiver of the business, have now decided that he shall be withdrawn, and the company allowed to continue as usual. A scheme of reconstruction is in progress. The works were established 85 years ago, and find employment for approximately 400 workpeople.

NORTH OF ENGLAND.

(From our own Correspondent.)

Ironworks to Close.

IT is announced that Dorman, Long and Co., Ltd., have made arrangements to put out of action the last blast-furnace at their Carlton Ironworks, near Stockton. Such a step had been expected in some quarters, following the increase of resources due to the recent amalgamation with Bolckow, Vaughan and Co., Ltd., but it will mean the virtual industrial extinction of the village of Stillington, where most of the workmen live. An official statement issued by the firm intimates that the furnace will be blown out at the beginning of March, and that it is impossible to say what the duration of the stoppage will be. The furnace has been producing ferro-manganese. This is to be produced in future by the Bolckow plant at South Bank. The decision to cease activities at the Carlton Ironworks has been prompted largely by the fact that the plant is obsolete. The blast-furnaces, for instances, are not associated with a steel-producing plant, as is the case in more modern works, with the result that there is a considerable wastage of gases. On the balance there will be no loss of employment, as another blast-furnace was lighted at South Bank a few days ago, and for that reason extra hands have been taken on there. The firm carries on other processes at Carlton, but the ironworks provided the chief source of employment.

Cleveland Iron Trade.

The volume of business passing in the Cleveland pig iron trade is still disappointing, but inquiries are, if anything, slightly better. Consumers are adopting a very cautious attitude, holding that, following further easing of raw material prices, they may be able to buy on lower terms. Ironmasters are determined not to allow second hands to hold sufficient iron to influence market values, and merchants may deal more extensively in iron from other home-producing centres, in the disposal of which they have a free hand. Oversea firms compete successfully for trade with Scotland, and export sales are difficult. No 1 Cleveland foundry iron is 75s., No. 3 G.M.B. 72s. 6d., No. 4 foundry 71s. 6d., and No. 4 forge, 71s.

Hematite Pig Iron.

East Coast hematite is in only moderate request and quotations are easy. Merchants hold rather considerable quantities, and are offering iron fairly freely. Market rates are not fixed, and customers are able to purchase from second hands at prices well below cost of production. Home business is not heavy, and export trade is almost at a standstill, owing to the comparative cheapness of foreign iron. Buyers state that they experience no difficulty in placing orders for ordinary East Coast brands at 78s., but some makers hold out for higher terms.

Iron-making Materials.

Consumers of foreign ore are not in the market for ordinary business, but have picked up a few cheap lots. Best Rubio is not more than 22s. 6d. c.i.f. Tees. Blast-furnace coke quotations are easy. Good medium descriptions are offered at 22s. delivered to works in the North-East Coast area.

Manufactured Iron and Steel.

Big outputs are being maintained in the manufactured iron and steel trade, and producers have still quite a large amount of work to execute. A few orders for constructional and shipbuilding steel are coming forward, but brisker business would be welcomed. Sheets are the quietest section of the market. Prices are not quotably altered, but market values of one or two commodities are not too strong.

The Coal Trade.

Requirements for February have been asserting themselves in the Northern coal trade this week, and the collieries have been able to keep to late figures, although through contractors' current quotations have been shaded for February and onwards. Notwithstanding the mildness of the winter, and the consequent lessened demand for fuel as compared with what was experienced in the early part of 1929, the trade requirements at home and abroad have been good, and in this district at least all supplies have been easily disposed of. The signs are that the volume of business will be maintained for weeks ahead, with a corresponding steadiness in prices. A favourable position is maintained for Northumberland steams. Large kinds are held at about 16s. 9d., with Tyne primes at 16s., and second quality large steams at 15s. 6d. to 15s. 9d. There is a fair request for small steams, which are quoted strongly at from 10s. 9d. to 11s. 6d., according to description. In practically every branch of the Durham market activity is mostly confined to the execution of prompt orders. There is no outstanding business developing from the inquiries at present circulating. Durham steams are firmly indicated at 17s. 6d. to 18s. 6d. for large and 14s. to 14s. 6d. for smalls. Prices for coking coal favour sellers, the basis being 15s. 9d. to 16s. Steadiness marks the gas coal section. Best gas fuel is 16s. 9d.; Wear specials, 17s. to 17s. 3d.; and seconds, 15s. 6d. to 15s. 9d. Bunkers still make from 16s. 6d. to 17s. for best or superior kinds, with seconds at 15s. 6d. to 15s. 9d. A dull state of affairs is continuing for coke. Gas coke is in moderate offer at 24s. 6d. to 25s., and there is plenty of ordinary patent foundry coke available from 19s. 6d. to 22s. These figures, however, are none too securely held.

SCOTLAND.

(From our own Correspondent.)

Steel and Iron.

MARKETS are, as a rule, comparatively quiet, conditions being hardly yet similar to those pertaining before the New Year holidays. Specifications for steel plates and sections are still rather slow in coming forward, owing, in a measure, to quietness in the shipbuilding industry, and also to poor export demands. Boiler plates also are poorly specified. Black steel sheets are comparatively well placed at the moment, more especially in the lighter gauges, but galvanised descriptions are a weak spot. So far as foreign demands are concerned, tube makers still find business hampered by the difficulties encountered in the negotiations for a renewal of the International Cartel. Bar iron and re-rolled steel hold little of fresh interest. The former is unchanged in price and the latter can still be obtained somewhere round about £7 12s. 6d. per ton, both for home and for export.

Scrap.

The amount of business done in scrap is restricted, buyers and sellers apparently being content to deal in small tonnages at current prices. Heavy steel is quoted about 70s.; cast iron machinery, 69s. 3d., and heavy basic 69s. 6d. per ton.

Coal.

Foreign demands are still on a very quiet basis, owing, it is said, to the fact that Scandinavian and continental countries had bought heavily over the winter months in order to avoid a repetition of the shortage caused at this time last year by unusually severe weather. At any rate, shippers cannot induce importers abroad to buy to any extent at present prices, even though they show, in many instances, a substantial reduction since the beginning of the present month. Lanarkshire splints and ells and Fifeshire best steams are well placed, but other descriptions of round coals are more easily obtainable. All sizes of washed nuts except singles are still weakening. Aggregate shipments amounted to 285,378 tons, against 260,653 tons in the preceding week and 239,164 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

EXTREMELY little change has taken place in the general conditions governing the coal trade of this district during the past week. The conditions may be described as somewhat colourless, inasmuch as there is no special feature, and it is evident that collieries are for the most part working on contracts that were arranged some time ago. New business cannot be said to be at all brisk, and yet shipments keep up very well. For last week the returns of the Great Western Railway Company show that over 657,000 tons of coal were shipped for foreign and coastwise destinations which compared with just over 631,000 tons for the preceding week. It was thought by this time that the situation might have been far worse, and that the supply of tonnage would have been unequal to requirements. It is true that some collieries could do with additional quantities, but the figures show that while at the end of last week there were twenty-two idle tipping appliances at the various ports, as against seven steamers waiting to berth, the position on Monday as the result of week-end arrivals was that nineteen steamers were waiting to load and only four tips were at a standstill, though on Tuesday the figures were twelve tips idle and eleven waiting steamers. The current inquiry for cargoes of coals is by no means what could be desired, and yet there are indications of some improvement. There is no doubt that, in addition to the fact that the weather abroad has been so mild as detrimentally to affect the demand for coals from this country, many buyers have been afraid to purchase more than only the very minimum quantities, owing to the steady downward trend of c.i.f. prices, brought about by the extraordinary weakness of outward freight rates. Rates must, however, be near bottom, and this view is evidently gaining ground abroad, as buyers are showing more interest in supplies for delivery over a period of three, six, and twelve months. Exporters undoubtedly will be very careful about taking c.i.f. risks over long periods, realising that there may be an upward turn in freight rates in the course of the next month or so. Intimation has been received that the Egyptian State Railways are inviting tenders for 250,000 tons of locomotive coals. The adjudication will take place on April 23rd. Details of the inquiry have not so far come to hand, but it is presumed that the coals will be required for shipment from about May to August or the end of the year, inasmuch as the current contract, which was secured by T. Beynon and Co., Ltd., runs up to May.

Coalowners and Mines Bill.

The main body of South Wales coalowners are opposing the Coal Mines Bill as part of the Mining Association of Great Britain, but an independent group has been formed with Sir Clifford Cory, Bart., as chairman of the Committee for the purpose of fighting the measure. This independent group of coalowners represents an aggregate output of about eleven million tons out of a total of forty-nine million tons produced last year in this coalfield. The undertakings represented are Ocean Coal Company, Ltd., Cory Brothers and Co., Ltd., Pyman, Watson and Co., Ltd., Locket's Merthyr Collieries, Ltd., Blaenavon Company, Ltd., and the Cardiff Collieries, Ltd., Llanbradach. The Ocean Collieries include the United National, Deep Navigation and Burnyeat, Brown. These coalowners have issued a statement of their policy and early this week circulated it among the members of the House of Commons.

Shipping.

It is many years since the state of shipping was so deplorable. The market, both outward and homeward, has for weeks been very bad, but is now worse, if anything. Outward rates have touched low levels that were undreamed of six months ago. In some directions, in fact, the actual rates are less than pre-war, so that the position of owners will be imagined when it is borne in mind that their running costs are 50 to 60 per cent. higher. There is hardly any outward business that can be secured at a rate which does not mean a loss for owners. For instance, Alexandria, for which the average freight for 1929 was 11s. 6¼d., has been done this week at 7s. 10½d. Genoa options, for which the average was 8s. 11d., has been fixed at 6s. 9d.; and Las Palmas, the average for which last year was 9s. 7d., has been done at 7s. 9d. The only direction for which rates outward display any steadiness is that for South America, but this is brought about by the fact that homeward business is so unremunerative. It is not surprising to find that many shipowners are laying up their tonnage, while it is evident that those firms which have taken up tonnage on time-charter must be having a deplorable time, as apart from the fact that rates of freight are bad, they are not getting their steamers turned round any too expeditiously, especially at the discharging ports.

Electricity.

Reporting on the Electricity Commissioners' scheme for South Wales, to the Electricity Committee of the Cardiff Corporation on Monday, the city electrical engineer, Mr. C. G. Morley New, described it as a true example of Christian Socialism, as instead of providing power for themselves only they would pass on the benefits of their economical generation to others. The scheme showed that Cardiff stood to save £34,849, or 5·48 per cent., over the period from 1931–37, which gave the lowest percentage of saving of all the selected stations. This indicated the economical working of the Cardiff station, as compared with other similar undertakings. He estimated that the capital expenditure on the Cardiff station, while operating under the Central Electricity Board, would be £176,000 over the period of 1931 to 1937. Under independent operation the capital expenditure would have been only £104,100. The accelerated development and increased cost would not in any way affect the exchequer of the municipal authority, because from the time when the Cardiff station would be taken over, the whole of the cost of extensions would be borne by the Central Electricity Board.

Dock Workers' Conditions at Newport.

Members of the Transport Workers' Union employed at Newport docks have been balloted on the proposal of the Joint Control Board regarding an alteration in the system of working from the gang system to a rota system. There was a majority in favour of the change, and therefore the new conditions will come into force from Monday next. The gang system will be substituted by a long rota, but the alteration will not make any difference in the distribution of wages.

Current Business.

The tone of the large coal market continues to be very quiet, and the position of many undertakings is that they have accumulations of these qualities which prove detrimental to regular working, and as a consequence interfere with the production of small coals. Large coals are for the most part on the minimum schedule basis, but small coals are very firm. Sized descriptions are not so active in demand and are rather easier. Patent fuel makers are busy, but coke is less in demand and prices are weaker. Pitwood is in good supply and prices are round about 26s. 6d. to 27s.

EDUCATIONAL INTELLIGENCE.

LONDON COUNTY COUNCIL SCHOOL OF ENGINEERING AND NAVIGATION, HIGH-STREET, POPLAR, E. 14.—A special course of five lectures on "High-tension Transmission and Distribution of Electrical Energy," will be held on Tuesday evenings, from 7 to 9 p.m., commencing Tuesday, February 4th, 1930. The lectures will be delivered by Mr. Edgar T. Painton, B.Sc., M. Amer. I.E.E., A.M.I.E.E. Those desiring to attend the course should make early application to the Secretary at the School.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, asks us to announce that it has acquired the sole British Rights of the Victaulic joint for use with cast iron pipes.

PERRIN'S Ltd., asks us to announce that its offices have been removed from Astor House, Aldwych, London, W.C. 2, to 3, Central Buildings, Westminster, London, S.W. 1. Telegraphic address, Fifperteen, London; telephone numbers, Victoria 7803/7804.

VIOZONE Ltd., of 88/90, Chancery-lane, London, W.C. 2, asks us to announce that it holds a licence for the sole manufacturing and selling rights of the Pyroversum pyrometer in England and the Colonies, and that the trade mark "Pyroversum" is registered in its name.

CONTRACTS.

JAMES POLLOCK, SONS AND CO., Ltd., 3, Lloyd's-avenue, London, E.C. 3, have recently supplied and superintended the fitting on board the "Osage" of two 350 B.H.P. four-cylinder Bolinder engines for the Anglo-American Oil Company.

YARROW AND CO., Ltd., of Scotstoun, Glasgow, W. 4, have received from the Japanese Government an order for a Yarrow boiler, land type, of 1000 lb. pressure and a steam temperature of 800 deg. Fah. The principal parts will be made at the firm's works and shipped to Japan, where the boiler and superheater will be tubed.

INTERNATIONAL COMBUSTION, Ltd., has received an order for a complete boiler plant, comprising boilers, air pre-heating equipment, pulverising plant and auxiliary machinery for the B'wana M'Kuba Copper Mines, South Africa, and an order for a complete stoker-fired boiler plant for the Ryde Pumping Station of the Sydney Water Board, Australia.

MERRYWEATHER AND CO., Ltd., have received from the London Fire Brigade a repeat order for two of their latest type motor fire engines. The same firm has also received the following orders:—From Margate, for a motor combination turntable fire ladder with "Hatfield" pump; from Carnforth, for a motor tender; for motor "Hatfield" fire engines from Stornoway and Tonbridge; and for motor fire appliances for brigades in the Colonies and foreign countries.

MIRRLEES, BICKERTON AND DAY, Ltd., of 7, Grosvenor-gardens, Westminster, S.W. 1, have received orders for Mirrlees-Diesel engines from The Shan States Silver Lead Corporation, Ltd., Burma (3–120 B.H.P.); The British Columbia Electric Railway Company, Vancouver (1–165 B.H.P.); The Mid-Kent Water Company (1–140 B.H.P., coupled to borehole pump); The Alexandria Water Company, Ltd. (1–150 B.H.P.); The Sind Flour Mills, Karachi (1–480 B.H.P.); Trivandrum (1–220 B.H.P.), and Manila (1–240 B.H.P.).

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has received from the Egyptian State Railways an order for the complete equipment of a 5000 kW generating station which is to be constructed at Gabbary, about a mile from Alexandria, for the supply of power for the railway workshops and also for public distribution in the district, including Alexandria. The equipment, covered by the order will include three turbo-alternator sets—one of 2500 kW and two of 1250 kW—boilers, superheaters and economisers, coal handling plant, fans, pumps, pipework, &c., and also the necessary switchgear and transformers for linking up to an existing 3300-volt distribution system and for supply to the station auxiliaries.

LAUNCHES AND TRIAL TRIPS.

BELAWAN, passenger and cargo steamer; built by the De Maas Shipbuilding Company, to the order of the Royal Packet Company, of Amsterdam; dimensions, 252ft. by 40ft. by 15ft. 6in. Engines, four-cylinder Lentz; trial trip, January 7th.

LADY PLYMOUTH, steamship; built by Wm. Gray and Co., Ltd., Cardiff, to the order of Lewis Lougher and Co., Ltd., Cardiff; dimensions, 413ft. 6in. by 54ft. 2½in. by 27ft. 6¼in.; to carry cargo. Engines, triple-expansion, 26in., 43in., 71in. by 48in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, January 9th.

WILLIAM WILBERFORCE, motor vessel; built by David and William Henderson and Co., Ltd.; to the order of the African Steamship Company; dimensions, length 370ft., breadth 51ft. 6in., depth 33ft. 6in.; to carry 5650 tons deadweight. Engines, eight-cylinder, single-acting, airless-injection, 740 mm. diameter by 1500 mm. stroke; constructed by Harland and Wolff, Ltd.; launch, January 14th.

BENEDICT, steamship; built by Cammell Laird and Co., Ltd., to the order of the Booth Steamship Company, Ltd.; dimensions, length 405ft., breadth 53ft. 6in., depth 36ft. 6in. Engines, inverted cylinder triple-expansion, pressure 220 lb. per square inch; constructed by the builders; launch, January 15th.

LANGLEEBROOK, steamship; built by Palmers Shipbuilding and Iron Company, Ltd., to the order of F. Carrick and Co., Ltd.; to carry about 8000 tons deadweight. Engines, triple-expansion; constructed by the builders; launch, January 15th.

LINDENDANE, steamship; built by Workman, Clark (1928), Ltd.; to the order of Andrew Weir and Co.; dimensions, length 420ft., breadth 56ft. 6in., depth 36ft. 3in.; gross tonnage, 5060 tons. Engines, direct-acting quadruple-expansion, 22in., 32in., 46½in. and 68in. diameter by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; trial trip, January 15th.

MAIPO, twin-screw oil tank steamer; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd., to the order of the Chilian Government; dimensions, length 378ft., breadth 49ft. 9in., depth 27ft. 3in. Engines, triple-expansion, 23½in., 38in., 64in. diameter by 42in. stroke, pressure 180 lb.; constructed by Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd.; launch, January 15th.

PORTAVON, coasting steamer; built by Goole Shipbuilding and Repairing Company (1927), Ltd.; to the order of the Portfield Steamship Company, Ltd.; dimensions, length 176ft., breadth 28ft. 4in., depth 13ft. 6in.; to carry 850 tons dead weight. Engines, triple-expansion; launch, January 16th.

PRINCE HENRY, turbine steamer; built by Cammell Laird and Co., Ltd., to the order of Canadian National Steamships, Ltd.; dimensions, length 384ft. 6in., breadth 57ft., depth 20ft. 2in.; to carry passengers and cargo. Engines, two sets of single-reduction geared turbines of Parsons type, pressure 350 lb. per square inch; constructed by the builders; launch, January 17th.

THOROLD, motor vessel; built by Earles Shipbuilding and Engineering Company, Ltd., to the order of Quebec and Ontario Transportation Company, Ltd.; dimensions, 250ft. long, 43ft. 9in. broad, 23ft. deep. Engines, single-acting, two-cycle, 4-cylinder Diesel, about 1000 B.H.P.; constructed by Sulzer Bros.; launch, January 18th.

ROMSEY, twin-screw passenger tender; built by Ferguson Brothers (Port-Glasgow), Ltd., to the order of Alexandra Towing Company, Ltd.; dimensions, length 140ft., breadth 34ft., depth 15ft. 6in.; launch, January 20th.

HIGHLAND HOPE, twin-screw passenger and cargo motor ship; built by Harland and Wolff, Ltd.; to the order of the Nelson Line; dimensions, length 520ft., breadth 69ft., depth 35ft. 9in. Engines, two eight-cylinder, double-acting, four-cycle engines; constructed by the builders; trial trip, January 25th.

FARADAY MEDAL.—The Council of the Institution of Electrical Engineers has made the ninth award of the Faraday Medal to Sir Ernest Rutherford, O.M., F.R.S. The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the Institution.

INSTITUTION OF NAVAL ARCHITECTS.—The seventy-first annual meeting of the Institution of Naval Architects will take place on Wednesday, April 9th, and the two following days, in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. Admiral of the Fleet the Right Hon. Lord Wester Wemyss, G.C.B., C.M.G., M.V.O., D.C.L., President, will occupy the chair. The annual dinner will be held on Wednesday, April 9th, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C. Arrangements are being made to hold a Summer Meeting in Liverpool on July 15th to 18th.

DETACHABLE SCALE.—Mr. Ernest S. Cervard, of Post Office Chambers, Portishead, Bristol, has kindly sent us a "detachable scale" which he is now putting on the market. The apparatus consists of a 12in. length of hard wood of triangular section. One side is hollowed to decrease the rubbing surface, whilst the other two are provided with simple spring clips. These clips retain two scales made of thin stainless steel, and, as each scale has two readings on each face, four scales in all are available. The inclination of the scale to the paper or work makes it easy to read and, of course, brings the divisions close to the surface. Any desired scales can be provided. It is a simple but convenient appliance for the drawing board or the workshop.

BRITISH ENGINEERING STANDARDS ASSOCIATION.—The Council of the British Engineering Standards Association feels that the occasion of the granting by His Majesty The King of the Royal Charter to the Association might fittingly be celebrated, and arrangements have been made to hold a banquet at the Grocers' Hall, Princes-street, E.C. 2 (by permission of the Master and Court of the Worshipful Company of Grocers), on Thursday, March 6th, at 6.45 for 7.15 p.m., when His Royal Highness the Duke of York, K.G., has kindly consented to be the chief guest and propose the toast of the Association. It is hoped that two or three of the Ministers of State will be present and that an announcement in regard to the Government policy towards the activities of the Association will be made.

THE LONDON SHIPPING ORCHESTRAL SOCIETY.—The date of the annual concert of the London Shipping Orchestral Society has been fixed for Wednesday, March 26th, 1930. The concert will be held at the Kingsway Hall, London, W.C. 2, and its proceeds will be given in aid of the Royal Merchant Seamen's Orphanage. The charities which have benefited during the last three years are:—(1) The Royal Alfred Aged Merchant Seamen's Institution; (2) the "Titanic" Engineering Staff Memorial Benevolent Fund, and (3) King George's Fund for Sailors. The Honorary Secretaries, F. G. Mountford (H. and W. Nelson, Ltd., 98, Leadenhall-street, E.C. 3) and W. H. Hammersley (Furness, Withy and Co., Ltd., Furness House, Leadenhall-street, E.C. 3) will be pleased to send details and to receive donations or subscriptions towards the charitable work of this society.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 21/–
(1) Spanish	21/6 to 23/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 18 0	3 18 0
No. 1	3 18 6	3 18 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
Midlands—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*) / 4 11 6 (*b*) / 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	13 0 0	12 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 15 0	—
Hoops	9 15 0 to 10 5 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	11 15 0 to 12 10 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/9 to 19/–
Block Tin (Cash)	176 7 6
„ (three months)	179 10 0
Copper (cash)	71 10 0
„ (three months)	68 8 9
Spanish Lead (cash)	21 11 3
„ „ (three months)	21 11 3
Spelter (cash)	19 16 3
„ (three months)	20 6 3
Manchester—	
Copper, Best Selected Ingots	77 17 6
„ Electrolytic	84 10 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	23 2 6
„ Foreign	21 12 6
Spelter	20 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/4½ per lb.	
Ferro Tungsten	3/1½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 7 6	7/6
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£39 0 0	15/–
„ „ „ 0·70 p.c. carbon	£41 10 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/10 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/6
„ „ Ell	16/–
„ „ Splint	17/– to 18/–
„ „ Trebles	15/6
„ „ Doubles	14/–
„ „ Singles	14/–
Ayrshire—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	17/6
„ „ Trebles	16/–
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	13/– to 15/6
Screened Navigation	18/– to 19/6
Trebles	16/6 to 17/6
Doubles	14/– to 14/6
Singles	13/6
Lothians—	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	14/–
Trebles	16/6
Doubles	14/–
Singles	14/–

ENGLAND.

(8) N.W. Coast—	
Steams	21/6 to 23/–
Household	38/– to 51/–
Coke	26/–
Northumberland—	
Best Steams	17/–
Second Steams	16/–
Steam Smalls	11/– to 11/6
Unscreened	13/– to 13/6
Household	25/– to 37/–
Durham—	
Best Gas	16/9 to 17/–
Second	15/6 to 15/9
Household	25/– to 37/–
Foundry Coke	25/– to 30/–
Sheffield—	Inland.
Best Hand-picked Branch	26/6 to 28/– —
Derbyshire Best Bright House	21/– to 23/– —
Best House Coal	20/6 to 21/6 —
Screened House Coal	18/6 to 20/– —
„ „ Nuts	16/6 to 18/– —
Yorkshire Hards	15/6 to 17/– —
Derbyshire Hards	15/6 to 17/– —
Rough Slacks	9/– to 10/– —
Nutty Slacks	7/6 to 8/6 —
Smalls	3/– to 5/– —
Blast-furnace Coke (Inland)	17/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	22/6 to 23/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 20/–
Best Dry Large	19/9 to 20/–
Ordinary Dry Large	19/– to 19/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/3 to 18/6
Best Eastern Valley Large	18/– to 18/3
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	14/9 to 15/–
Ordinary Smalls	13/6 to 14/6
Washed Nuts	19/6 to 28/–
No. 3 Rhondda Large	21/– to 21/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/3 to 17/6
„ „ Through	15/6 to 16/6
„ „ Smalls	14/6 to 15/–
Foundry Coke (Export)	32/6 to 37/–
Furnace Coke (Export)	29/– to 30/–
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	26/6 to 26/9
Swansea—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/–
Seconds	30/– to 32/6
Red Vein	26/– to 28/–
Machine-made Cobbles	43/6 to 45/6
Nuts	45/– to 47/6
Beans	26/– to 28/6
Peas	20/– to 20/6
Breaker Duff	10/9 to 11/3
Rubbly Culm	12/6 to 13/–
Steam Coals :	
Large	20/– to 21/–
Seconds	18/6 to 19/6
Smalls	13/6 to 14/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Merchant Marine.

THE situation of the mercantile marine has been deplored for so long a time without any satisfactory remedy being found for the present state of things that the recent debate in the Chamber of Deputies on the Budget Estimates gave special prominence to the measures that could be employed by the State for giving aid to both shipowners and shipbuilders. There is no decline of the marine, since the actual tonnage of nearly 3,500,000 is a million more than that of 1914, but it is declared that France has fallen to the fifth rank amongst maritime countries and that the depreciation of shipping is not made good by the construction of new vessels. Shipowners labour under disabilities, such as the eight-hour day, which make it difficult for them to compete with foreign freights, and shipbuilders are unable to compete with foreign shipyards on account of higher costs and, more particularly, it is affirmed, of a want of specialisation. It was stated during the debate that the six ships ordered from Belfast were placed at one-half the price with a guarantee of one-half the time of delivery of that asked by French shipbuilders. The real cause of the present agitation, apart from the necessity of finding work for the shipyards, is a desire to create a marine that will keep pace with colonial development, for it is quite understood that the African and other Colonies will, in time, supply the country with practically all the raw material it needs. Therefore, the present tonnage must be maintained by the construction of something like 200,000 tons a year, or more than double the amount that was built in French shipyards during 1929. The difficulties in the way of providing for more economical shipbuilding are so great on account of their complexity, that the whole matter has been referred to the Conseil National Economique, which will fully investigate the matter and suggest methods for putting the shipbuilding industry on a satisfactory basis.

Coal.

On his election as President of the Société des Ingénieurs Civils, Monsieur Cuvelette, general director of the Lens Colliery Company, presented an address on the coal mining industry that was optimistic as to the future, for the reserves of coal, he said, are so enormous that time is bound to work in its favour. There are at present known to exist in the world 5600 million tons of coal which, at the present rate of consumption, would last 4000 years, while the known oil deposits will not provide for present consumption for a period of forty years. The high initial cost of hydro-electric power stations is a point in favour of coal. It is, said M. Cuvelette, a significant fact that, even in the marine, pulverised coal is beginning to make headway against oil fuel, and it will probably be recognised that the advantages of liquid fuels are possessed by coal in this form. The president also dealt with the situation of the coal trade in general, and in Great Britain in particular, and attributed the crisis not only to the development of the coal mining industry on the Continent, but also to the State control of British mines during the war, and for some time afterwards, when wages were increased far above the level for economical working. Finally, it was suggested that a stabilisation of the industry could be effected much more satisfactorily by means of international arrangements, whereby each country maintained its independence, than by an attempt to insure an international control of the coal mining industry.

Electrical Production.

The aspects of electrical production by hydraulic and thermal means were dealt with at a meeting at Grenoble of the Société Scientifique du Dauphiné by Monsieur Paul Bergeon, who showed that the installation of electrical generating plants at the collieries was changing the privileged situation of hydro-electric power stations, which could no longer claim any appreciable advantage from the point of view of economy. With the use of pulverised small coal, of otherwise practically no value, and of high steam pressures and temperatures, the collieries had got the cost of electricity down to a very low figure, and some of them were using surplus supplies for electro-chemical manufactures. Under those circumstances, the only hope for the hydro-electric plants lay in the supply of cheap capital for their construction, and that should be done by the State, to which reverts the ownership of the hydro-electric power stations at the end of 75 years. Monsieur Bergeon believes that a reduction of the charges on capital will enable the hydraulic production of electricity to hold its own. During the discussion on the paper, it was regarded as essential to effect a close association between the thermal and hydraulic sources of supply so that current could be distributed under the most satisfactory conditions. In this connection it is interesting to note that the Grenoble municipality has decided to lay down a heat plant in order to provide for any irregularities of its hydro-electric supply, which, of course, comes from Alpine sources, that are liable to fail during severe winters and dry summers.

The Super-liner.

There have been rumours to the effect that the Cie. Général Transatlantique had abandoned the idea, at all events for the present, of constructing the 60,000-ton liner, the order for which had been given to the Chantiers de Penhoët. It is now declared that the vessel will be built, although its service will be delayed by the longer time that will be required to construct the combined lock and dry dock—350 m. long—between the Penhoët basin and the sea, which will have to be completed before a ship of that size can be launched. It is not expected, therefore, that the big liner can be put into service before the spring of 1934.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

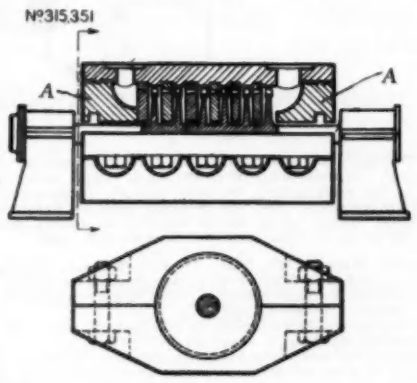
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

315,351. May 22nd, 1929.—STEAM OR GAS TURBINES. Aktiengesellschaft der Maschinenfabriken Escher Wyss et Cie., of 19, Hardturmstrasse, Zurich, Switzerland.

This invention relates to a steam or gas turbine with a casing made of forged material and divided in a central plane, and the object of the invention is to facilitate the execution of the forging work and also to cheapen it, while, at the same time, ensuring that the material of the forged parts shall be homogeneous in consequence of their special shape. In order to attain these advantages the casing is made of substantially prismatic shape, on its outer periphery, as shown in the lower illustration, but

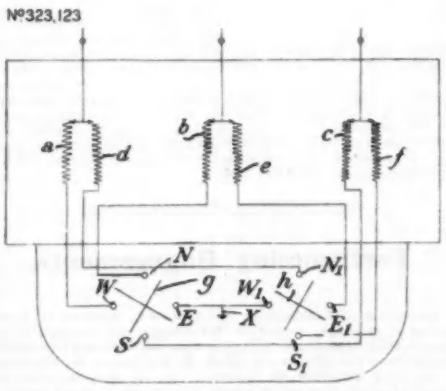


on its inner circumference of substantially cylindrical shape, and it is, moreover, closed in at each end by cylindrical plugs A, also divided in an axial plane. Casings of this kind are particularly well suited for high-pressure high-temperature steam turbines. The closing plugs may be conveniently provided on their outer peripheries with annular projections, which engage in grooves in the casing. Furthermore, these plugs may be constructed on their inner circumference as labyrinth bushes, so that they pack the shafts which pass through them. These grooves, which are fine, ensure, it is claimed, efficient packing and permit the forged casing to be produced with a minimum of machining.—*December 24th*, 1929.

ELECTRICAL APPLIANCES.

323,123. January 3rd, 1929.—A.C. LOAD TRANSFERRING SWITCHES, Alfred William George Tucker and Ferranti Ltd., of Hollinwood.

This invention relates to load transferring switches, *i.e.*, switches which are operated in association with tap changing switches for electric transformers. According to the invention only two switches are employed for load transferring irrespective of the number of phases. Considering one unit first, the four fixed contacts, which may be referred to as N., S., E. and W., as representing the points of the compass, are connected as follows:—W. is connected to one half winding *a* of phase 1; N. is connected to the corresponding half winding *b* of phase 2; E. is connected to the neutral point X and to W.^{1} of unit 2; S. is connected to the corresponding half winding *c*

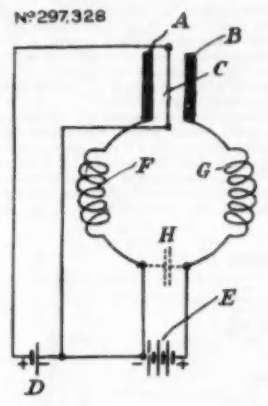


of phase 3. Considering now unit 2:—N.^{1} is connected to the other half winding *d* of phase 1; E.^{1} is connected to the other half winding *e* of phase 2, and S.^{1} is connected to the other half winding *f* of phase 3. When both cross-shaped movable contacts *g*, *h* are in position connecting together N., S., E., and W., and N.^{1}, S.^{1}, E.^{1} and W.^{1} of the respective units, both winding portions *a* and *d*, *b* and *e*, *c* and *f* of each phase will be connected together at one end and connected to the neutral point X. When, however, the movable contact *g* of unit 1 opens the circuit of the contact points N., S., E. and W. of that unit one winding portion of each of the three phases will simultaneously be isolated from the neutral point and from one another, thus enabling the necessary change of tapping point to be effected, while the remaining portion of the phase windings remain on load.—*December 24th*, 1929.

TELEGRAPHS AND TELEPHONES.

297,328. September 17th, 1928.—GENERATION OF ELECTRIC OSCILLATIONS, Süddeutsche Telefon-Apparate-Kabel-und Drahtwerke Aktiengesellschaft, of 185, Allersbergerstrasse, Nürnberg, Germany, and Karl Kohl, of 22, Margüardsen Strasse, Erlangen, Germany.

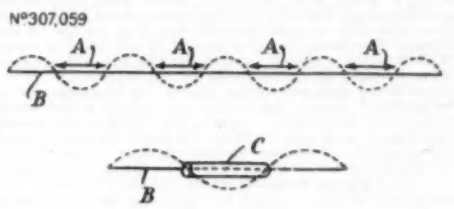
This invention relates to an arrangement for the generation of electric oscillation for the purpose of producing short electromagnetic waves, and more particularly short waves from 1 m. downwards. A and B are the plates of a condenser and C an incandescent filament heated by a battery D. One pole of the battery is connected to the negative pole of a battery E, which is of comparatively high voltage. Pressures in the neighbourhood of 100 volts are sufficient. The negative pole of the battery E is connected over a self-inductance F to the plate A of the condenser, whilst the positive pole of the battery is connected over a self-inductance G to the other plate B of the condenser. The oscillation is produced as follows:—If a high positive voltage be applied to the plate B, a stream of electrons flows from the filament C over the plate B and the self-inductance G and,



by capacity coupling over the capacity H which is the capacity possessed by the leads, and bridges the battery E and then over F to the second plate A of the condenser, which thus receives a negative charge. The high negative charge of A thus produced is now discharged in the opposite direction and, since A becomes more positive, a stream of electrons flows from the filament C over F, H, G, to the plate B, which now receives a negative charge. If B is again discharged, it becomes more positive and the operation is repeated so that an undamped oscillation is produced in the circuit B, G, H, F and A. The wave length of the circuit is determined by the capacity between the plates A and B, by the self-inductances F and G, and, finally, by the bridging over capacity H.—*December 17th*, 1929.

307,059. February 13th, 1929.—AERIALS, Telefunken Gesellschaft fur drahtlose Telegraphie m.b.H., of 12–13, Hallesche Ufer, Berlin, Germany.

This invention relates more particularly to aerials of the kind in which the radiation from certain portions of the aerial is annulled or suppressed. Separate conductors A are associated with an aerial B and are arranged parallel thereto at and along alternate half wave-lengths. In the lower diagram a conductive

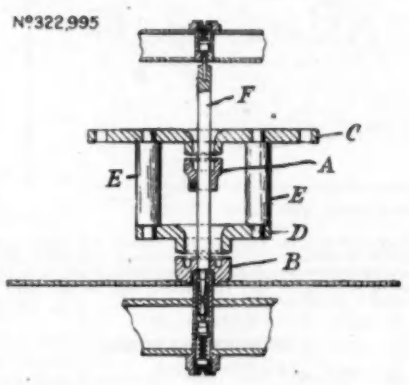


cylinder or tube C is employed to screen one-half wave-length of an aerial. The screening conductor or conductors may, if desired, be constituted by so-called "Reusen" assemblies of wires, *i.e.*, by lattice-like arrangements of wires. Further, if desired, the screening conductor or conductors may be excited not by the aerial oscillations, as in the cases illustrated, but by energy of opposite phase impressed directly thereon through feeders.—*December 24th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

322,995. June 15th, 1928.—MAGNETIC SUSPENSION DEVICES, Sebastian Ziani de Ferranti and Ferranti, Ltd., both of Hollinwood, Lancaster.

This specification describes a magnetic suspension device particularly for electricity meter rotors of the kind wherein a partial balance is effected between the magnetic pull and the force due to gravity upon the mass of the moving system. The illustration shows the invention applied to the suspension of the rotor of an induction watt meter. On the spindle of the rotor are two



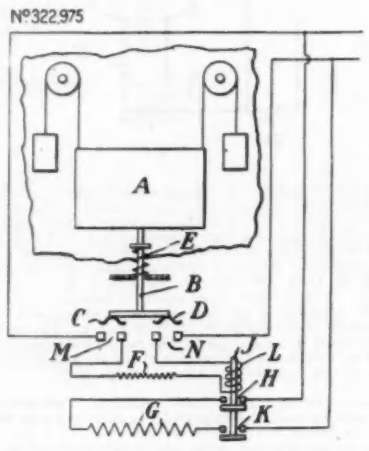
mild steel cupped members A, B, with the rims facing upwards. Above each of these cups there is a pair of permanent magnets C, D, with down-turned ends adjacent the cups, the down-turned ends being shaped to correspond with the rims of the cups, but separated from these rims by an air gap. The magnets are separated from each other by non-magnetic pillars E. The strength of the magnets and the air gap are so adjusted that an upward force is applied to the rotor spindle F at least about 10 per cent. greater than the downward force thereon due to gravity, so that the spindle exerts an upward thrust against

the upper bearing. The magnets are accurately centred so that substantially no side thrust is produced at either bearing, and owing to the substantially uniform nature of the magnetic field of the permanent magnets very small magnetic drag is introduced.—*December 16th*, 1929.

FURNACES.

322,975. March 20th, 1929.—ELECTRIC FURNACES, Lancelot William Wild and Wild-Barfield Electric Furnaces, Ltd., both of Elecfurn Works, North-road, Holloway, London, N 7.

It is common practice to embody in the construction of an electric furnace a thermal fuse which, by melting, cuts off all power from the heaters should the furnace temperature from any cause rise sufficiently high to endanger the furnace or the work within it. This fuse must of necessity be exposed to the full furnace temperature, and it is difficult and often impossible so to guard it that it cannot be touched by the tools of the furnace operator when charging or discharging the furnace, when the operator might receive a severe shock. It is proposed to obviate this danger by connecting in the fuse circuit a two-pole switch which opens the circuit cutting off the supply from both poles of the fuse and leaving the fuse dead as soon as the door is opened. A illustrates the door of an electric furnace supported by counterbalance weights. The door is adapted automatically to operate a double-pole switch B, carrying the two contacts C, D, the switch being

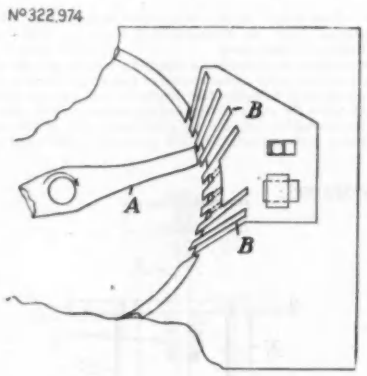


normally opened by a lifting spring E and closed when the door is lowered by being depressed. The switch B opens and closes the fuse circuit, breaking the circuit at both ends of the fuse F. The heater element G is included in a main circuit which is broken at H and K, the breaks being adapted to be simultaneously closed by a spring-controlled switch J operated by a solenoid L in series with the fuse F in the fuse or shunt circuit. The shunt circuit is broken by the pairs of contacts M, N, situated at opposite ends of the fuse, the pairs of contacts being arranged to be connected by the members C, D when the switch is depressed by the door A. In operation, the door being closed, current passes through the fuse F and solenoid L to cause the switch J to make the heater circuit including the element G. If now, the fuse breaks, the switch J opens the heater circuit. When the operator requires to open the door for any purpose, the spring E lifts the switch B so that the fuse circuit is again open, and in that case also the switch J thereupon opens the heater circuit, so that both poles of the heater G as well as both poles of the fuse F are left dead. Thus, both the fuse and heater are rendered innocuous when the door of the furnace A is opened.—*December 19th*, 1929.

CRUSHING AND GRINDING.

322,974. March 15th, 1929.—AN IMPROVED GRINDING FACE FOR PULVERISING MACHINES, G. Clark, 261, Beverley-road, Hull.

In this machine the grinding effect takes place between the ends of the rotating arm A and the inner ends of the plates B B.

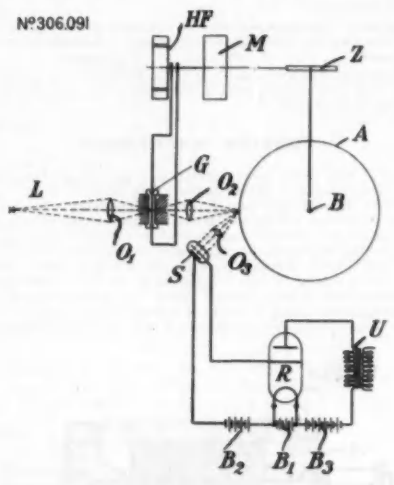


It is claimed that the action of the rotating arm will be such as to induce an inward draught of air between the blades, and that, as a consequence, the material being ground will be kept in a state of suspension and the blades can be set very close together.—*December 19th*, 1929.

MISCELLANEOUS.

306,091. February 13th, 1929.—APPARATUS FOR PICTURE TELEGRAPHY, C. Lorenz Aktiengesellschaft, of 1, Lorenzweg, Berlin-Tempelhof, Germany.

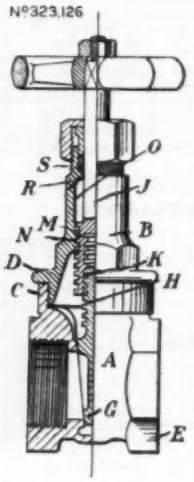
The picture cylinder A is driven by means of a motor M, a toothed wheel Z which is mounted on the shaft A of the picture cylinder being interposed. A high-frequency dynamo HF is coupled with the driving motor. The high-frequency currents (4–6000 periods per second) are conveyed to the thread of the string galvanometer G. The light ray emanating from the light source L and collected by the optical device O_1 is concentrated upon the light-controlling device G. The light ray falling through the slit of the galvanometer is concentrated on the picture cylinder through the optical device O_2 and the reflected light conveyed through the optical device O_3 to the light-sensitive cell S, which is in the grid circuit of the input tube R of an amplifier. A corresponding auxiliary voltage is imparted to the light-sensitive cell by the battery B_3, whilst the batteries B_1 and B_2 represent the heating battery and anode battery respectively.



The currents are conveyed to the further amplifying device through the transformer U in the anode circuit of the valve. Since the galvanometer oscillates with the frequency of the current generated in the high-frequency machine, a periodically chopped current, which can be amplified as desired, flows in the anode circuit of the valve R.—*December 24th*, 1929.

323,126. January 9th, 1929.—VALVES, Newman, Hender and Co., Ltd., of Woodchester, near Stroud, Gloucester, and Charles Percy Newman, of "The Knoll," Amberley, near Stroud, Gloucester.

The object of this invention is to provide an improved valve which will be cheap to construct and efficient in action. The casing of the valve comprises two members, a body A and a bonnet B which are screwed together by threaded parts C and D on the members A and B respectively. The body A is provided with hexagonal ends E which are threaded inside to receive water pipes, and is also provided with a tapered slot adapted to accommodate the correspondingly tapered slide G. Integral with the slide G is a threaded spindle H, which works inside another spindle J threaded internally at K and externally at M, the external thread engaging a threaded part N on the bonnet B. The upper end of the spindle J passes through the bonnet and is provided with a hand wheel secured to the spindle by a nut. The member B is provided with a housing O to receive the threaded portion M of the spindle when the slide is open, an annular bearing R and a gland S which is secured to the bonnet by a nut. By turning the hand wheel the threaded parts N and M co-act, thereby raising the slide. The slide is prevented from rotating by the walls of the slot so that the spindle H and the thread K also co-act, accelerating the raising of the gate. By the double action of the spindles, caused by the right and left-handed threads respectively, the gate can be opened and closed with very few turns of the wheel. In the drawings the spindles are provided with multiple-start square threads The spindle J rises above the bonnet of the valve as the gate opens, so that the position of the gate is indicated by observing the length of the spindle exposed. With a valve made according to this invention, it is claimed that the gate is raised with great ease from its seating, owing to the double purchase which can be exercised by a combination of threaded spindles such as described.—*December 24th*, 1929.



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

DIESEL ENGINE USERS ASSOCIATION.—In Caxton Hall, Caxton-street, Westminster, London, S.W. 1. "High-powered Oil Engines for Land Purposes," by Mr. W. S. Burn. 3.30 p.m.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (associated with the Faraday Society.)—Northampton Polytechnic Institute, St. John-street, London, E.C. 1. Convention and Exhibition. An exhibition representative of modern scientific and practical advances in electro-deposition will be on view at the Institute during the day. "Research and Practice," by Dr. W. Rosenhain, F.R.S., 4 p.m. A discussion will take place on "The Present Position of Chromium Plating," 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. Paper, "Superheating," by Mr. F. Onions, illustrated by film. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate Section. Joint meeting. "The Electrical Propulsion of Ships," by Mr. W. G. Thompson. 7.15 p.m.

ROYAL CORPS OF NAVAL CONSTRUCTORS.—Park-lane Hotel, Piccadilly, W. 1. Annual dinner.

SATURDAY, FEBRUARY 1ST.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual dinner at the Dudley Arms Hotel, Dudley. 6 p.m.

MONDAY, FEBRUARY 3RD.

BRADFORD ENGINEERING SOCIETY.—In the Hall of the Bradford Technical College. "The Steam Turbine for Power and Heating in Mills," by Mr. R. McLean, illustrated by lantern slides. 7.30 p.m.

SOCIETY OF ENGINEERS.—In the Apartments of the Geological Society, Burlington House, W. 1. Presidential address by Mr. W. M. Beckett. 6 p.m.

TUESDAY, FEBRUARY 4TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Nickel Casting Alloys," by Mr. John McNeil. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Relative Safety of Mild and High-tensile Steel under Alternating and Pulsating Stresses," by Professor B. P. Haigh. 7.45 p.m.

WEDNESDAY, FEBRUARY 5TH.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Annual dinner, Midland Hotel, Manchester. 6.30 for 7 p.m.

THURSDAY, FEBRUARY 6TH.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Modern Aerodynamical Research in Germany," by Mr. J. W. Maccoll. 6.30 p.m.

FRIDAY, FEBRUARY 7TH.

CHEMICAL ENGINEERING GROUP.—Joint meeting with Birmingham Section. Visit to the Landor-street works and, if time permits, the works of the General Electric Company, Ltd. 2.15 p.m. In the Chamber of Commerce, New-street, Birmingham. "Electric Furnaces for Heat Treatment," by Mr. A. G. Lobley. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Diving," by Dr. Leonard Hill, F.R.S. 9 p.m.

MONDAY, FEBRUARY 10TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Pyrometry," by Mr. S. H. Hawkins. 7.30 p.m.

TUESDAY, FEBRUARY 11TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Electric Heating," by Mr. W. Richardson. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper to be submitted for discussion, "The Diversion of the River Ashop," by Mr. R. W. Scott Thompson. 6 p.m.

WEDNESDAY, FEBRUARY 12TH.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—In the Thomas Café, High-street. "The Corrosion of Non-ferrous Metals," by Dr. A. G. Ramsay. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal meeting. Subject for discussion, "The Influence of the Progress of Aeronautical Engineering on other Branches of Engineering Work," by Mr. Lucien Alphonse Legros. 6 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. "The Water Supply of the Metropolis," by Mr. H. E. Stilgoe. 7.30 p.m.

THURSDAY, FEBRUARY 13TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "Temperature Measurement and Control in Works," by Mr. H. H. Smith. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Progress of the Autogiro since 1925," by Senor J. de la Cierva. 6.30 p.m.

FRIDAY, FEBRUARY 14TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square. "Recent Developments in Measuring Instruments," by Mr. S. Matthews. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, London, S.W. 1. Informal meeting. Lantern lecture, by Mr. G. Stevenson Taylor, followed by a visit to the Home Office Industrial Museum. 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Annual dinner, Midland Hotel. 6.45 for 7.15 p.m.

MONDAY, FEBRUARY 17TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lectures—"Recent Improvements in Methods of Brickmaking," by Mr. Alfred B. Searle. 8 p.m.

MONDAY TO FRIDAY, FEBRUARY 17TH TO 28TH.

BRITISH INDUSTRIES FAIR.—Olympia and Castle Bromwich, Birmingham.

WEDNESDAY, FEBRUARY 19TH.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. "Gliding," by Dr. Georgii. 6.30 p.m.

THURSDAY, FEBRUARY 27TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Creep of Metals at High Temperatures," by Mr. R. W. Bailey. 7 p.m.

FRIDAY, MARCH 7TH.

INSTITUTE OF MARINE ENGINEERS.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 for 7.30 p.m.

SATURDAY, MARCH 29TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Trocadero Restaurant, London. Annual dinner.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—The following are the new officers of the F.H.O.S.A. for the current year:—President, S. B. Haslam, M.I.E.E., M.I. Mech. E.; Vice-president, J. A. Taylor, Assoc. M. Inst. C.E., A.M.I.E.E.; Members of Council, Dr. W. R. C. Coode-Adams, Ph.D., M.A., M.Sc., G. W. Gray, Major G. A. B. Leishman, M.C., A.M.I.E.E., Major C. E. Prince, M.I.E.E., H. S. Selves and H. E. Webb, A.M.I.E.E.